MINERALS YEARBOOK

1963

Volume III of Four Volumes

AREA REPORTS:

Domestic

Prepared by staff of the
BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR • Stewart L. Udall, Secretary

BUREAU OF MINES • Marling J. Ankeny, Director

Created in 1849, the Department of the Interior—a Department of Conservation—is concerned with the management, conservation, and development of the Nation's water, fish, wildlife, mineral, forest, and park and recreational resources. It also has major responsibilities for Indian and Territorial affairs.

As the Nation's principal conservation agency, the Department works to assure that nonrenewable resources are developed and used wisely, that park and recreational resources are conserved for the future, and that renewable resources make their full contribution to the progress, prosperity, and security of the United States—now and in the future.

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1964

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402 - Price $4.25

Engineering
ML
.U2N3
M1
1964
3

1477929

FOREWORD

The 1963 MINERALS YEARBOOK marks the 82d year in which this publication or its predecessors have been issued by the Federal Government. It also marks the first issue of a fourth volume reviewing world mineral production, consumption, and trade on a country-by-country basis. This new international review volume represents the Bureau's continuing effort to make the Yearbook as useful as possible to industry, Government, and the general public.

Many difficulties had to be surmounted in preparing this new volume. Although it has not been possible in several instances to present international data comparable to those available for the United States, the international review should nevertheless prove a valuable reference.

The general content of this four-volume edition is as follows:

Volume I contains chapters on metal and on nonmetal mineral commodities except mineral fuels. In addition, it includes a chapter reviewing these mineral industries, a statistical summary, and chapters on mining and metallurgical technology, employment and injuries, and technologic trends.

Volume II contains a chapter on each mineral fuel and on such related products as helium, carbon black, peat, coke, and coal chemicals, and natural gas liquids. Also included are data on employment and injuries in the fuel industries, and a mineral-fuels review summarizing recent economic and technological developments.

Volume III contains chapters covering each of the 50 States, United States island possessions in the Pacific Ocean, the Commonwealth of Puerto Rico, and island possessions in the Caribbean Sea, including the Canal Zone. Volume III also has a statistical summary chapter, identical with that in Volume I, and a chapter on employment and injuries.

Volume IV contains 124 chapters presenting the latest available mineral statistics for more than 130 foreign countries and areas, and 1 chapter reviewing minerals in world economy.

To my knowledge, the Minerals Yearbook is the most comprehensive publication of its kind available. The Bureau will continue its efforts in the years to come to increase the Yearbook's value to its many users. Toward that end, the constructive comments and suggestions of readers will be helpful.

MARLING J. ANKENY, *Director.*

747-416—64

ACKNOWLEDGMENTS

In preparing this volume of the MINERALS YEARBOOK, the Bureau of Mines was assisted in collecting statistical data and mineral-industry information by State agencies, through cooperative agreements. Many State chapters were reviewed by staff members of these agencies, and in some instances the staff members collaborated in preparing the chapters and are shown as coauthors. For this assistance acknowledgment is made to the following cooperating organizations:

Alabama: Geological Survey of Alabama.
Alaska: Department of Natural Resources.
Arizona: Arizona Bureau of Mines.
Arkansas: Geological and Conservation Commission; Arkansas Oil and Gas Commission; Department of Revenue.
California: Division of Mines and Geology; The Public Utility Commission.
Colorado: The Oil and Gas Conservation Commission and the Coal Mines Inspection Department.
Delaware: Delaware Geological Survey.
Florida: Florida Geological Survey.
Georgia: Geological Survey of Georgia.
Hawaii: Department of Land and Natural Resources.
Idaho: Bureau of Mines and Geology.
Illinois: State Geological Survey Division.
Indiana: Geological Survey, Department of Conservation.
Iowa: Iowa Geological Survey.
Kansas: Conservation Division, State Corporation Commission and State Geological Survey of Kansas.
Kentucky: Kentucky Geological Survey, Department of Mines and Minerals.
Louisiana: Louisiana Geological Survey and Louisiana Department of Conservation.
Maine: Geological Survey of Maine.
Maryland: Department of Geology, Mines, and Water Resources.
Michigan: Geological Survey Division, Department of Conservation.
Mississippi: Mississippi Geological Survey, Mississippi State Oil and Gas Board, and Oil and Gas Severance Tax Division, Mississippi State Tax Commission.
Missouri: Division of Geological Survey and Water Resources, Department of Business and Administration.
Montana: Montana Bureau of Mines and Geology, The Oil and Gas Conservation Commission.
Nevada: Nevada Bureau of Mines.
New Hampshire: New Hampshire State Planning and Development Commission.
New Jersey: Bureau of Geology and Topography.
New York: New York State Science Service.
North Carolina: Geological Survey of North Carolina.
North Dakota: North Dakota Geological Survey.
Ohio: Department of Natural Resources and Department of Industrial Relations.
Oklahoma: Oklahoma Geological Survey and Oil and Gas Conservation Department; Oklahoma Corporation Commission, Gross Production Division; Oklahoma Tax Commission.
Oregon: State Department of Geology and Mineral Industries.
Pennsylvania: Bureau of Topographic and Geological Survey.
Puerto Rico: Mineralogy and Geology Section, Economic Development Administration, Commonwealth of Puerto Rico.

South Carolina: Geological Survey of South Carolina.
South Dakota: State Geological Survey.
Tennessee: Department of Conservation and Commerce.
Texas: Bureau of Economic Geology, The University of Texas; Oil and Gas Division, Railroad Commission of Texas; Oil and Gas Division, State Comptroller of Public Accounts.
Utah: Utah Geological and Mineralogical Survey.
Virginia: Division of Mineral Resources.
Washington: Division of Mines and Geology, Department of Conservation and Development.
West Virginia: West Virginia Geological and Economic Survey.
Wisconsin: Wisconsin Geological Survey.
Wyoming: The Geological Survey of Wyoming.

Except for two review chapters, this volume was prepared by the staffs of the Mineral Resource Offices of the Bureau of Mines. Statisticians and researchers in the Area offices who gave substantial assistance to the authors of the chapter were: In Area I, Harold F. York, James V. Luxner, Marlyn J. Ackerman, Robert E. Ela, Roy H. Davis, Michael E. Bursic, Victoria M. Dorchak, Stephanie A. Dzienis, Carrie Gardner, Mary E. Otte, Jean A. Pendleton, Madaline P. Stewart. In Area II, Martha E. Peeples, Mildred K. Rees, and Mildred Rivers. In Area III, Wanda J. West, Richard J. Bishop, Ella R. Humenansky, Theodore A. Myren, Estelle E. Rand, and Don N. West. In Area IV, Dorothy Underwood, Betty Siggins and the Statistical Staff. In Area V, Stella K. Drake, Elsie J. Kellogg, Ruth C. Nichols, and Virginia R. Coykendall. In Area VI, Leo Giorgetti, Sophie H. Chibidakis, and Marcelo F. Dacanay. In Area VII, Mrs. Clara Hutcheson and the Statistical Staff. In Area VIII, Holly G. O'Brien.

Preparation of the volume was under the general direction of Paul F. Yopes, Assistant to the Chief, Division of Minerals. The manuscripts upon which this volume is based have been reviewed to insure statistical consistency among the tables, figures, and text, between this volume and volumes I and II, and between this volume and those for former years, by a staff supervised by Kathleen J. D'Amico, who was assisted by Julia Muscal, Helen L. Gealy, Helen E. Tice, Mary E. Daugherty, Nellie W. Fahrney, Robert E. Anderson, and Joseph Spann.

Minerals Yearbook compilations are based largely on facts provided by the mineral industries. Acknowledgment is made of the willing contribution by both companies and individuals of these essential data.

CHARLES W. MERRILL,
Chief, Division of Minerals.

CONTENTS

	Page
Foreword, by Marling J. Ankeny	III
Acknowledgments, by Charles W. Merrill	V
Statistical summary, by Kathleen J. D'Amico	1
Employment and injuries in the mineral industries, by Forrest T. Moyer	49
The mineral industry of—	
Alabama, by Avery H. Reed, Jr. and Thomas Simpson	57
Alaska, by Kevin Malone and Phil R. Holdsworth	75
Arizona, by L. P. Larson	99
Arkansas, by Raymond B. Stroud	135
California, by L. E. Davis	159
Colorado, by D. H. Mullen	225
Connecticut, by James R. Kerr	271
Delaware, by Samuel A Gustavson	281
Florida, by Lawrence E. Shirley and William D. Reves	285
Georgia, by James L. Vallely and Garland Peyton	307
Hawaii, by Roy Y. Ashizawa	323
Idaho, by Jerry J. Gray, Richard W. Knostman, and Norman S. Petersen	333
Illinois, by Matthew G. Sikich and Richard E. Dawes	359
Indiana, by Donald F. Klyce and Mary B. Fox	391
Iowa, by John W. Sweeney	411
Kansas, by W. G. Diamond, P. L. Hilpman, A. L. Hornbaker, and R. G. Hardy	427
Kentucky, by Harold L. Riley and Preston McGrain	463
Louisiana, by Peter Grandone, Owen W. Jones, and Leo W. Hough	485
Maine, by Joseph Krickich	519
Maryland, by N. A. Eilertsen	527
Massachusetts, by Robert W. Metcalf	539
Michigan, by Donald F. Klyce	549
Minnesota, by L. F. Heising and R. C. Briggs	575
Mississippi, by Nicholas A. Kendall and Frederic F. Mellen	601
Missouri, by A. Kuklis and William C. Hayes	619
Montana, by Richard W. Knostman and A. J. Kauffman, Jr	649
Nebraska, by Carl L. Bieniewski	677
Nevada, by L. E. Davis and Roy Y. Ashizawa	693
New Hampshire, by Stanley A. Feitler	719
New Jersey, by Charles C. Yeloushan	725
New Mexico, by W. E. Burleson	739
New York, by Stanley A. Feitler	771
North Carolina, by James R. Boyle and Jasper L. Stuckey	797
North Dakota, by D. H. Mullen	815
Ohio, by Joseph Krickich	831
Oklahoma, by Robert B. McDougal, and William E. Ham	861
Oregon, by Frank B. Fulkerson, William N. Hale, and Gary A. Kingston	891
Pennsylvania, by James R. Kerr	909
Puerto Rico, Panama Canal Zone, Virgin Islands, and Pacific Island Possessions, by Harry F. Robertson, José F. Cadilla, Leovigildo Vázquez, and Roy Y. Ashizawa	951
Rhode Island, by Samuel A. Gustavson	959
South Carolina, by Lawrence E. Shirley and Henry S. Johnson, Jr	963
South Dakota, by Carl L. Bieniewski and Duncan J. McGregor	979
Tennessee, by James R. Boyle and William D. Hardeman	995
Texas, by F. F. Netzeband and Roselle M. Girard	1015
Utah, by Merwin H. Howes	1079

Page

The mineral industry of—Continued
Vermont, by James R. Kerr 1107
Virginia, by Robert W. Metcalf and James L. Calver 1115
Washington, by Jerry J. Gray and William N. Hale 1145
West Virginia, by James R. Kerr 1165
Wisconsin, by Wesley A. Grosh 1187
Wyoming, by F. D. Everett 1207

Statistical Summary

By Kathleen J. D'Amico [1]

Contents

	Page
Mineral production:	
United States	1
Canal Zone and islands administered by the United States	38
Commonwealth of Puerto Rico	39
U.S. imports of principal minerals and products	40
U.S. exports of principal minerals and products	43
Comparison of world and U.S. production of principal metals and minerals	46

THIS summary appears in Minerals Yearbook volumes I and III, which cover mineral production in the United States, its island possessions, the Canal Zone, and the Commonwealth of Puerto Rico, as well as the principal minerals imported into and exported from the United States. The several commodity and area chapters contain further details on production. A summary table comparing world and U.S mineral production also is included.

TABLE 1.—Value of mineral production in the United States,[1] 1925–63, by mineral groups [2]

(Millions)

Year	Mineral fuels	Nonmetals (except fuels)	Metals	Total	Year	Mineral fuels	Nonmetals (except fuels)	Metals	Total
1925	$2,910	$1,187	$715	$4,812	1945	$4,569	$888	$774	$6,231
1926	3,371	1,219	721	5,311	1946	5,090	1,243	729	7,062
1927	2,875	1,201	622	4,698	1947	7,188	1,338	1,084	9,610
1928	2,666	1,163	655	4,484	1948	9,502	1,552	1,219	12,273
1929	2,940	1,166	802	4,908	1949	7,920	1,559	1,101	10,580
1930	2,500	973	507	3,980	1950	8,689	1,822	1,351	11,862
1931	1,620	671	287	2,578	1951	9,779	2,079	1,671	13,529
1932	1,460	412	128	2,000	1952	9,616	2,163	1,617	13,396
1933	1,413	432	205	2,050	1953	10,257	2,350	1,811	14,418
1934	1,947	520	277	2,744	1954	9,919	2,733	1,518	14,170
1935	2,013	564	365	2,942	1955	10,780	3,076	2,055	15,911
1936	2,405	685	516	3,606	1956	11,741	3,391	2,358	17,490
1937	2,798	711	756	4,265	1957	12,709	3,387	2,137	18,233
1938	2,436	622	460	3,518	1958	11,589	3,466	1,594	16,649
1939	2,423	754	631	3,808	1959	11,950	3,861	1,570	17,381
1940	2,662	784	752	4,198	1960	12,142	3,868	2,022	18,032
1941	3,228	989	890	5,107	1961	12,357	3,946	1,927	18,230
1942	3,568	1,056	999	5,623	1962	[3] 12,784	[3] 4,117	1,937	[3] 18,838
1943	4,028	916	987	5,931	1963	13,296	4,318	2,006	19,620
1944	4,574	836	900	6,310					

[1] Excludes Alaska and Hawaii, 1925–53.
[2] Data for 1925–46 are not strictly comparable with those for subsequent years, since for earlier years value of heavy clay products has not been replaced by value of raw clays used for such products.
[3] Revised figure.

[1] Statistical officer, Division of Minerals.

Mineral production may be measured at any of several stages of extraction and processing. The stage of measurement used in the chapter is normally what is termed "mine output." It usually refers to minerals in the form in which they are first extracted from the ground, but customarily includes for some minerals the product of auxiliary processing operations at or near mines.

Because of inadequacies in the statistics available, some series deviate from the foregoing definition. The quantities of gold, silver, copper, lead, zinc, and tin are recorded on a mine basis (as the recoverable content of ore sold or treated). The values assigned to these quantities, however, are based on the average selling price of refined metal, not the mine value. Mercury is measured as recovered metal and valued at the average New York price for metal.

The weight or volume units shown are those customary in the particular industries producing the respective commodities. No adjustment has been made in dollar values for changes in purchasing power of the dollar.

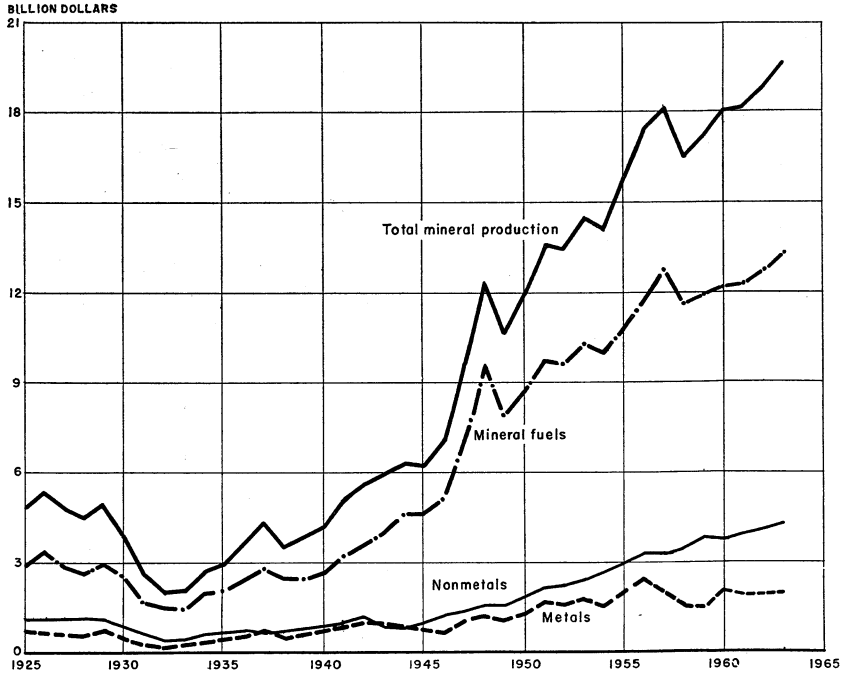


FIGURE 1.—Value of mineral production in the United States, 1925–63.

TABLE 2.—Mineral production [1] in the United States

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Mineral fuels:								
Asphalt and related bitumens (native):								
Bituminous limestone and sandstone—short tons	1,242,874	$3,070	1,558,792	$12,818	1,647,063	$14,601	1,632,645	$8,383
Gilsonite—do	383,037	10,020						
Carbon dioxide, natural (estimate)—thousand cubic feet	521,169	99	545,354	82	1,144,107	146	1,295,545	178
Coal:								
Bituminous and lignite [2]—thousand short tons	415,512	1,950,425	402,977	1,844,563	422,149	1,891,553	458,928	2,013,309
Pennsylvania anthracite—do	18,817	147,116	17,446	140,338	16,894	134,094	18,267	153,503
Helium—thousand cubic feet	475,179	7,768	551,785	10,263	599,519	20,905	627,344	21,957
Natural gas—million cubic feet	12,771,038	1,789,970	13,254,025	1,996,241	13,876,622	2,145,301	14,746,663	2,328,030
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	5,842,507	416,819	6,105,463	412,019	6,244,522	444,817	6,534,967	439,173
LP gases—do	8,444,074	391,566	9,085,465	370,186	9,409,083	353,334	10,302,250	359,770
Peat—short tons	470,889	5,138	531,067	5,036	[3] 566,441	5,186	546,621	5,423
Petroleum (crude)—thousand 42-gallon barrels	2,574,933	7,420,181	2,621,758	7,565,582	2,676,189	7,774,051	[4] 2,752,723	[4] 7,966,651
Total mineral fuels		12,142,000		12,357,000		[3] 12,784,000		13,296,000
Nonmetals (except fuels):								
Abrasive stone [5]—short tons	2,539	240	2,495	238	2,653	260	2,693	255
Aplite—long tons	(6)	(6)	97,465	651	125,156	912	(6)	(6)
Asbestos—short tons	45,223	4,231	52,814	4,347	53,190	4,677	66,606	5,425
Barite—do	714,276	8,574	796,804	9,300	860,312	9,820	823,615	9,447
Boron minerals—do	640,591	47,550	602,613	46,936	646,613	49,336	700,183	54,981
Bromine—thousand pounds	175,010	44,637	180,798	44,517	190,747	46,617	203,333	48,558
Cement:								
Portland—thousand 376-pound barrels	321,646	1,089,134	314,821	1,048,832	325,476	1,070,371	342,036	1,095,884
Masonry—thousand 280-pound barrels			19,275	55,737	19,998	57,405	20,997	59,599
Natural and slag—thousand 376-pound barrels			269	968	402	1,611	352	1,407
Clays—thousand short tons	49,069	162,411	47,389	156,829	47,797	163,012	50,199	180,874
Emery—short tons	8,169	142	6,180	106	4,316	71	6,732	119
Feldspar—long tons	502,380	4,779	496,808	5,120	492,476	5,076	548,954	5,525
Fluorspar—short tons	229,782	10,391	197,354	8,940	206,026	9,166	199,843	8,998
Garnet (abrasive)—do	10,522	986	12,057	1,036	14,166	1,172	14,626	1,412
Gem stones (estimate)	(7)	1,188	(7)	1,309	(7)	1,296	(7)	1,421
Gypsum—thousand short tons	9,825	35,690	9,500	34,996	9,969	36,343	10,388	38,138
Lime—do	12,935	172,731	13,249	177,463	13,752	186,754	14,521	199,389
Magnesite—short tons	498,528	2,051	603,656	3,129	492,471	[3] 1,621	527,655	1,779
Magnesium compounds from sea water and brine (except for metals) short tons, MgO equivalent	293,454	21,903	356,384	25,545	408,129	28,742	506,849	38,699

See footnotes at end of table.

TABLE 2.—Mineral production [1] in the United States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Nonmetals—Continued								
Mica:								
Scrap—short tons	97,912	$2,698	99,044	$2,417	107,702	$2,639	109,323	$2,776
Sheet—pounds	587,401	3,108	526,007	3,386	[3] 363,016	[3] 1,299	102,961	13
Perlite—short tons	312,153	2,665	310,338	2,664	320,330	2,663	325,132	2,727
Phosphate rock—thousand long tons	17,516	117,041	18,559	130,535	19,382	134,304	[12] 19,855	[12] 139,861
Potassium salts—thousand short tons, K_2O equivalent	2,638	89,676	2,732	104,464	2,452	94,859	2,865	109,276
Pumice—thousand short tons	2,210	5,569	2,463	6,799	[3] 2,271	[3] 6,301	2,618	6,578
Pyrites—thousand long tons	1,016	7,936	988	7,418	916	6,809	825	5,698
Salt—thousand short tons	25,479	161,140	25,707	160,223	28,807	174,841	30,644	184,635
Sand and gravel—do	709,792	720,432	751,784	751,301	776,701	794,725	822,000	849,000
Sodium carbonate (natural)—short tons	808,624	20,865	805,828	20,444	977,584	24,330	1,119,081	27,616
Sodium sulfate (natural)—do	449,631	8,706	465,814	9,296	457,881	9,092	435,257	8,392
Stone [8]—thousand short tons	616,784	952,555	611,938	947,359	656,954	1,025,697	688,366	1,068,108
Sulfur:								
Frasch process mines—thousand long tons	5,003	115,494	5,082	117,884	4,917	107,069	4,995	99,014
Other mines—long tons	181,422	1,732	177,549	1,694	150,550	1,439	1,371	15
Talc, soapstone, and pyrophyllite—short tons	734,473	5,378	762,380	5,277	771,728	5,278	804,358	5,505
Tripoli—do	57,713	247	54,641	225	61,732	244	66,635	266
Vermiculite—thousand short tons	199	3,108	206	3,350	205	3,293	226	3,572
Value of items that cannot be disclosed: Calcium-magnesium chloride, diatomite, epsom salts from epsomite (1961–63), graphite, iodine, kyanite, lithium minerals, greensand marl, olivine, staurolite, wollastonite, and values indicated by footnote 6	----------	42,664	----------	44,863	----------	47,815	----------	53,026
Total nonmetals	----------	3,868,000	----------	3,946,000	----------	[3] 4,117,000	----------	4,318,000
Metals:								
Antimony ore and concentrate—short tons, antimony content	635	(9)	689	(9)	631	(9)	645	(9)
Bauxite—long tons, dried equivalent	1,997,827	21,107	1,228,032	13,937	1,369,007	15,609	1,524,700	17,234
Beryllium concentrate—short tons, gross weight	509	162	[10] 1,122	(9)	[10] 978	(9)	[10] 751	(9)
Chromite—do	[11] 107,000	[11] 3,813	[11] 82,000	[11] 2,939	----------	----------	----------	----------
Copper (recoverable content of ores, etc.)—short tons	1,080,169	693,468	1,165,155	699,093	1,228,421	756,707	1,213,166	747,310
Gold (recoverable content of ores, etc.)—troy ounces	1,666,772	58,336	1,548,270	54,189	1,542,511	53,990	1,454,010	50,889
Iron ore, usable (excluding byproduct iron sinter) thousand long tons, gross weight	82,963	724,131	72,378	650,501	69,969	618,242	73,563	678,177
Lead (recoverable content of ores, etc.)—short tons	246,669	57,722	261,921	53,956	236,956	43,602	253,369	54,727
Manganese ore (35 percent or more Mn)—short tons, gross weight	80,021	5,352	46,088	3,224	24,758	(9)	10,622	(9)

Manganiferous ore (5 to 35 percent Mn)—do	658,455	4,466	225,004	1,480	338,501	(9)	543,125	(9)
Mercury—76-pound flasks	33,223	7,002	31,662	6,257	26,277	5,024	19.100	3,618
Molybdenum (content of concentrate)—thousand pounds	69,941	87,406	66,753	87,925	50,506	69,390	65,839	91,096
Nickel (content of ore and concentrate)—short tons	14,079	(9)	13,133	(9)	13,110	(9)	13,394	(9)
Silver (recoverable content of ores, etc.)—thousand troy ounces	30,766	27,846	34,794	32,166	36,798	39,929	35,243	45,076
Tin (content of ore and concentrate)—long tons	10	12	(9)	(9)	(9)	(9)	(9)	(9)
Titanium concentrate:								
Ilmenite—short tons, gross weight	789,237	14,655	782,629	13,320	809,037	13,974	890.071	16,529
Rutile—do	9,226	957	7,664	778	8,033	933	11,311	1,262
Tungsten ore and concentrate—short tons, 60-percent WO_3 basis	7,325	9,815	8,245	10,565	8,429	11,639	5,657	7,202
Uranium ore—short tons	7,970,211	152,188	8,041,329	148,299	7,052,870	138,294	5,947,571	119,215
Vanadium (recoverable in ore and concentrate)—do	4,971	17.749	5,343	19,076	5,211	18,605	3,853	13,756
Zinc (recoverable content of ores, etc.)—do	435,427	112,365	464,390	106,848	505,491	116,413	529,254	122,533
Value of items that cannot be disclosed: Chromite,[11] cobalt, magnesium chloride for magnesium metal, manganiferous residuum, platinum-group metals (crude), rare-earth metal concentrates, zirconium concentrate, and values indicated by footnote 9		23,078		22,582		35,071		36,827
Total metals		2,022,000		1,927,000		1,937,000		2,006,000
Grand total mineral production		18,032,000		18,230,000		[3]18,838,000		19,620,000

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Includes small quantity of anthracite mined in States other than Pennsylvania.
[3] Revised figure.
[4] Preliminary figure.
[5] Grindstones, pulpstones, millstones (weight not recorded), grinding pebbles, sharpening stones, and tube-mill liners.
[6] Figure withheld to avoid disclosing individual company confidential data; value included with "Nonmetal items that cannot be disclosed."
[7] Weight not recorded.
[8] Excludes abrasive stone, bituminous limestone, bituminous sandstone, and ground soapstone, all included elsewhere in table.
[9] Figure withheld to avoid disclosing individual company confidential data; value included with "Metal items that cannot be disclosed."
[10] Includes low-grade beryllium ore as follows: 805 tons in 1961, 760 tons in 1962, and 750 tons in 1963.
[11] Excludes quantity consumed by American Chrome Co.
[12] Final figure; superseded figure given in commodity chapter.

TABLE 3.—Minerals produced in the United States and principal producing States in 1963

Mineral	Principal producing States in order of quantity	Other producing States
Antimony	Idaho	
Aplite	Va	
Asbestos	Vt., Calif., Ariz., N.C	
Asphalt	Tex., Utah, Ala., Mo	
Barite	Mo., Ark., Nev., Ga	Calif., Idaho, Ky., Mont., N. Mex., S.C., Tenn., Tex.
Bauxite	Ark., Ala., Ga	
Beryllium	Colo	S. Dak., Utah, Wyo.
Boron	Calif	
Bromine	Mich., Tex., Ark., Calif	
Calcium-magnesium chloride	Mich., Calif., W. Va	
Carbon dioxide	N. Mex., Colo., Utah, Calif	Wash.
Cement	Calif., Pa., Tex., Mich	Ala., Ariz., Ark., Colo., Fla., Ga., Hawaii, Idaho, Ill., Ind., Iowa, Kans., Ky., La., Maine, Md., Minn., Miss., Mo., Mont., Nebr., N. Mex., N.Y., N.C., Ohio, Okla., Oreg., S.C., S. Dak., Tenn., Utah, Va., Wash., W. Va., Wis., Wyo.
Clays	Ohio, Ga., Tex., Calif	All other States except Alaska and R.I.
Coal	W. Va., Pa., Ky., Ill	Ala., Alaska, Ark., Colo., Ga., Ind., Iowa, Kans., Md., Mo., Mont., N. Mex., N. Dak., Ohio, Okla., S. Dak., Tenn., Utah, Va., Wash., Wyo.
Cobalt	Pa	
Copper	Ariz., Utah, N. Mex., Nev	Calif., Colo., Idaho, Mich., Mo., Mont., N.C., Oreg., Pa., S. Dak., Tenn., Wash.
Diatomite	Calif., Nev., Wash., Ariz	Md., Oreg.
Emery	N.Y	
Feldspar	N.C., Calif., Conn., Ga	Ariz., Colo., Maine, N.H., S.C., S. Dak., Va.
Fluorspar	Ill., Ky., Mont., Nev	Colo., Utah.
Garnet, abrasive	N.Y., Idaho	
Gold	S. Dak. Utah, Ariz., Alaska	Calif.,Colo., Idaho, Mont., Nev., N. Mex., N.C., Oreg., Pa., Tenn., Wash., Wyo.
Graphite	Tex	
Gypsum	Calif., Mich., Iowa, Tex	Ariz., Ark., Colo., Ind., Kans., La., Mont., Nev., N. Mex., N.Y., Ohio, Okla., S. Dak., Utah, Va., Wyo.
Helium	Tex., Okla., N. Mex., Kans	
Iodine	Mich., Calif	
Iron ore	Minn., Mich., Calif., N.Y	Ala., Ariz., Ark., Colo., Ga., Idaho, Mo., Mont., Nev., N.J., N. Mex., N.C., Pa., Tenn., Tex., Utah, Va., Wis., Wyo.
Kyanite	Va., S.C., Ga	
Lead	Mo., Idaho, Utah, Colo	Alaska, Ariz., Calif., Ill., Kans., Ky., Mont., Nev., N. Mex., N.Y., N.C., Okla., Oreg., S. Dak., Va., Wash., Wis.
Lime	Ohio, Mich., Mo., Pa	Ala., Ariz., Ark., Calif., Colo., Conn., Fla., Hawaii, Idaho, Ill., Iowa, La., Md., Mass., Minn., Miss., Mont., Nebr., Nev., N.J., N. Mex., N.Y., Okla., Oreg., S. Dak., Tenn., Tex., Utah, Vt., Va., Wash., W. Va., Wis., Wyo.
Lithium	N.C., Calif., S. Dak	
Magnesite	Nev., Wash	
Magnesium chloride	Tex	
Magnesium compounds	Mich., Calif., Tex., N.J	Fla., Miss.
Manganese ore	N. Mex., Mont	
Manganiferous ore	Minn., Mich., N. Mex., Mont	
Marl, greensand	N.J., Md	
Mercury	Calif., Nev., Alaska, Ariz	Idaho, Oreg.
Mica:		
Scrap	N.C., Ga., Ala., S.C	Ariz., Calif., Colo., Conn., Idaho, N. Mex., Pa., S. Dak.
Sheet	N.C., S. Dak	

TABLE 3.—Minerals produced in the United States and principal producing States in 1963—Continued

Mineral	Principal producing States in order of quantity	Other producing States
Molybdenum	Colo., Utah, Ariz., Calif.	Nev., N. Mex.
Natural gas	Tex., La., Okla., N. Mex.	Ala., Alaska, Ariz., Ark., Calif., Colo., Fla., Ill., Ind., Kans., Ky., Md., Mich., Miss., Mo., Mont., N.Y., N. Dak., Ohio, Pa., Tenn., Utah, Va., W. Va. Wyo.
Natural gas liquids	Tex., La., Okla., Calif.	Ark., Colo., Fla., Ill., Kans., Ky., Mich., Miss., Mont., Nebr., N. Mex., N. Dak., Pa., Utah, W. Va., Wyo.
Nickel	Oreg.	
Olivine	Wash., N.C.	
Peat	Mich., Ind., Calif., Wash.	Colo., Conn., Fla., Ga., Idaho, Ill., Iowa, Maine, Md., Mass., Minn., Mont., N.J., N.Y., N. Dak., Ohio, Pa., S.C., Wis.
Perlite	N. Mex., Ariz., Nev., Calif.	Colo., Idaho, Utah.
Petroleum	Tex., La., Calif., Okla.	Ala., Alaska, Ariz., Ark., Colo., Fla., Ill., Ind., Kans., Ky., Mich., Miss., Mo., Mont., Nebr., Nev., N. Mex., N.Y., N. Dak., Ohio, Pa., S. Dak., Tenn., Utah, Va., W. Va., Wyo.
Phosphate rock	Fla., Tenn., Idaho, Mont.	Ark., Utah, Wyo.
Platinum-group metals	Alaska, Calif.	
Potassium salts	N. Mex., Calif., Utah, Mich.	Md.
Pumice	Ariz., Calif., Oreg., N. Mex.	Colo., Hawaii, Idaho, Kans., Nebr., Nev., Okla., Tex., Utah, Wash., Wyo.
Pyrites	Tenn., Colo., Pa., Ariz.	S.C.
Rare-earth metals	Calif., Fla.	
Salt	La., Tex., N.Y., Ohio	Ala., Calif., Colo., Hawaii, Kans., Mich., Nev., N. Mex., N. Dak., Okla., Utah, Va., W. Va.
Sand and gravel	Calif., Mich., Ohio, N.Y.	All other States.
Silver	Idaho, Ariz., Utah, Mont.	Alaska, Calif., Colo., Ky., Mich., Mo., Nev., N. Mex., N.Y., N.C., Oreg., Pa., S. Dak., Tenn., Wash.
Sodium carbonate	Wyo., Calif.	
Sodium sulfate	Calif., Tex., Wyo.	
Staurolite	Fla.	
Stone	Pa., Tex., Ill., Calif.	All other States.
Sulfur (Frasch)	Tex., La.	
Sulfur ore	Calif., Nev.	
Talc, soapstone, and pyrophyllite.	N.Y., Calif., N.C., Vt.	Ala., Ark., Ga., Md., Mont., Nev., Pa., Tex., Va., Wash.
Tin	Colo., Calif.	
Titanium	N.Y., Fla., N.J., Va.	Idaho.
Tripoli	Ill., Okla., Pa.	
Tungsten	Calif., Colo., N.C., Nev.	
Uranium	N. Mex., Wyo., Colo., Utah.	Alaska, Ariz., Calif., Mont., Nev., N. Dak., Oreg., S. Dak., Tex., Wash.
Vanadium	Colo., Utah, Ariz., Wyo.	Idaho, N. Mex., Pa., S. Dak.
Vermiculite	Mont., S.C., Colo., Wyo.	
Wollastonite	N.Y., Calif.	
Zinc	Tenn., Idaho, N.Y., Colo.	Ariz., Calif., Ill., Kans., Ky., Mo., Mont., Nev., N.J., N. Mex., N.C., Okla., Oreg., Pa., Utah, Va., Wash., Wis.
Zirconium	Fla.	

TABLE 4.—Value of mineral production in the United States, and principal minerals produced in 1963

(Thousands)

State	Value	Rank	Percent of U.S. total	Principal minerals in order of value
Alabama	$215,870	21	1.10	Coal, cement, stone, petroleum.
Alaska	67,840	38	.35	Petroleum, sand and gravel, coal, gold.
Arizona	481,392	12	2.45	Copper, sand and gravel, cement, molybdenum.
Arkansas	167,196	25	.85	Petroleum, stone, bauxite, sand and gravel.
California	1,525,359	3	7.77	Petroleum, natural gas, cement, sand and gravel.
Colorado	317,109	17	1.62	Petroleum, molybdenum, coal, sand and gravel.
Connecticut	20,614	45	.11	Stone, sand and gravel, lime, feldspar.
Delaware	1,341	50	.01	Sand and gravel, stone, clays, gem stones.
District of Columbia	78	51	(1)	Clays.
Florida	201,620	23	1.03	Phosphate rock, stone, cement, clays.
Georgia	119,476	28	.61	Clays, stone, cement, sand and gravel.
Hawaii	15,307	46	.08	Cement, stone, sand and gravel, pumice.
Idaho	82,755	33	.42	Silver, lead, zinc, sand and gravel.
Illinois	583,943	8	2.97	Petroleum, coal, stone, sand and gravel.
Indiana	202,530	22	1.03	Coal, cement, stone, petroleum.
Iowa	97,670	30	.50	Cement, stone, sand and gravel, gypsum.
Kansas	518,302	9	2.64	Petroleum, natural gas, cement, stone.
Kentucky	434,746	14	2.22	Coal, petroleum, stone, natural gas.
Louisiana	2,662,061	2	13.57	Petroleum, natural gas, natural gas liquids, sulfur.
Maine	14,104	47	.07	Cement, sand and gravel, stone, clays.
Maryland	70,250	36	.36	Stone, cement, sand and gravel, coal.
Massachusetts	32,661	43	.17	Sand and gravel, stone, lime, clays.
Michigan	492,032	11	2.51	Iron ore, cement, copper, petroleum.
Minnesota	453,543	13	2.31	Iron ore, sand and gravel, stone, cement.
Mississippi	219,938	20	1.12	Petroleum, natural gas, cement, sand and gravel.
Missouri	158,991	27	.81	Stone, cement, lead, lime.
Montana	182,027	24	.93	Petroleum, copper, sand and gravel, zinc.
Nebraska	98,706	29	.50	Petroleum, cement, sand and gravel, stone.
Nevada	85,440	32	.44	Copper, sand and gravel, lime, diatomite.
New Hampshire	6,154	48	.03	Sand and gravel, stone, clays, feldspar.
New Jersey	73,276	34	.37	Stone, sand and gravel, zinc, iron ore.
New Mexico	686,822	7	3.50	Petroleum, potassium salts, natural gas, copper.
New York	260,221	18	1.33	Cement, stone, sand and gravel, salt.
North Carolina	44,894	41	.23	Stone, sand and gravel, feldspar, clays.
North Dakota	94,504	31	.48	Petroleum, sand and gravel, natural gas, coal.
Ohio	419,396	15	2.14	Coal, stone, cement, lime.
Oklahoma	872,518	4	4.45	Petroleum, natural gas, natural gas liquids, cement.
Oregon	62,692	39	.32	Stone, sand and gravel, cement, nickel.
Pennsylvania	856,864	5	4.37	Coal, cement, stone, iron ore.
Rhode Island	2,807	49	.01	Sand and gravel, stone. gem stones.
South Carolina	36,479	42	.19	Stone, cement, clays, sand and gravel.
South Dakota	55,058	40	.28	Gold, sand and gravel, stone, cement.
Tennessee	160,723	26	.82	Stone, cement, coal, zinc.
Texas	4,413,084	1	22.49	Petroleum, natural gas, natural gas liquids, cement.
Utah	385,521	16	1.96	Copper, petroleum, uranium, coal.
Vermont	24,391	44	.12	Stone, asbestos, sand and gravel, talc.
Virginia	229,065	19	1.17	Coal, stone, cement, sand and gravel.
Washington	71,430	35	.36	Sand and gravel, cement, stone, zinc.
West Virginia	767,815	6	3.91	Coal, natural gas, natural gas liquids, stone.
Wisconsin	68,326	37	.35	Sand and gravel, stone, cement, iron ore.
Wyoming	504,633	10	2.57	Petroleum, natural gas, uranium, sodium carbonates and sulfates.
Total	19,620,000	--------	100.00	Petroleum, natural gas, coal, cement.

[1] Less than 9.005 percent.

TABLE 5.—Mineral production [1] in the United States, by States

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ALABAMA								
Cement: [2]								
Portland—thousand 376-pound barrels	12,931	$42,706	12,445	$39,027	12,482	$40,164	12,218	$38,417
Masonry—thousand 280-pound barrels			2,006	6,156	2,187	6,521	2,386	7,242
Clays [3]—thousand short tons	1,840	2,170	1,787	2,068	1,632	1,947	607	3,003
Coal (bituminous)—do	13,011	92,439	12,915	90,903	12,880	95,149	12,359	91,243
Gem stones							[4]	2
Iron ore (usable)—thousand long tons, gross weight	4,068	23,511	3,597	20,510	2,962	17,838	2,126	11,806
Lime—thousand short tons	536	6,593	579	6,871	522	6,298	596	6,974
Natural gas—million cubic feet	57	4	56	4	128	13	177	21
Petroleum (crude)—thousand 42-gallon barrels	7,329	[5]	6,931	19,060	7,473	19,355	[6] 9,175	[6] 23,763
Sand and gravel—thousand short tons	4,359	4,759	5,800	6,452	4,655	4,486	5,363	5,778
Stone [7]—do	13,503	19,970	13,651	19,909	12,680	19,667	13,684	22,206
Value of items that cannot be disclosed: Native asphalt, bauxite, slag cement, clays (kaolin), scrap mica, sheet mica (1960–62), salt, stone (dimension limestone, dimension marble 1960–61, shell 1960–61, 1963, crushed sandstone 1960–61), talc, and values indicated by footnote 5		29,650		7,919		8,347		5,415
Total		221,802		218,879		[8] 219,785		215,870
ALASKA								
Clays—thousand short tons	1	$10						
Coal (bituminous)—do	722	6,318	737	$5,868	871	$6,409	853	$5,910
Copper (recoverable content of ores, etc.)—short tons	41	26	92	55				
Gold (recoverable content of ores, etc.)—troy ounces	168,197	5,887	114,216	3,998	165,259	5,784	99,573	3,485
Lead (recoverable content of ores, etc.)—short tons	[5]	[5]	[5]	[5]			5	1
Mercury—76-pound flasks	4,459	940	4,129	816	3,719	711	400	76
Natural gas—million cubic feet	246	30	631	129	2,184	467	4,498	1,111
Peat—short tons	376	[5]			64	[5]		
Petroleum (crude)—thousand 42-gallon barrels	559	1,230	6,327	17,652	10,259	31,187	[6] 10,740	[6] 32,650
Sand and gravel—thousand short tons	6,013	5,483	5,241	4,185	5,731	5,355	16,926	22,005
Silver (recoverable content of ores, etc.)—thousand troy ounces	26	23	18	17	22	24	14	18
Stone—thousand short tons	275	852	[5]	[5]	[5]	[5]	[5]	[5]
Value of items that cannot be disclosed: Gem stones, platinum-group metals, uranium ore, and values indicated by footnote 5		1,061		2,033		4,255		2,584
Total		21,860		34,753		[8] 54,192		67,840

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ARIZONA								
Beryllium concentrate—short tons, gross weight	(9)	(10)	8	$4	1	(10)		
Clays [8]—thousand short tons	173	$260	165	240	139	$184	163	$203
Coal (bituminous)—do	6	58						
Copper (recoverable content of ores, etc.)—short tons	538,605	345,784	587,053	352,232	644,242	396,853	660,977	407,162
Gem stones	(4)	120	(4)	119	(4)	120	(4)	120
Gold (recoverable content of ores, etc.)—troy ounces	143,064	5,007	145,959	5,109	137,207	4,802	140,030	4,901
Lead (recoverable content of ores, etc.)—short tons	8,495	1,988	5,937	1,223	6,966	1,282	5,815	1,256
Lime—thousand short tons	148	2,430	167	2,686	174	2,914	181	3,048
Manganese ore (35 percent or more Mn)—short tons, gross weight	1,626	40						
Manganiferous ore (5 to 35 percent Mn)—do	8,677	190	(5)	(5)				
Mercury—76-pound flasks	(5)	(5)	148	29	(5)	(5)	(5)	(5)
Molybdenum (content of concentrate)—thousand pounds	4,359	5,211	4,878	6,232	4,412	5,864	5,553	7,584
Natural gas—million cubic feet					230	27	1,334	161
Petroleum (crude)—thousand 42-gallon barrels	73	(5)	73	(5)	39	(5)	[6] 55	(5)
Pumice—thousand short tons	703	1,164	745	1,893	756	1,640	800	1,877
Sand and gravel—do	14,490	14,235	17,688	16,175	15,579	17,404	15,037	14,466
Silver (recoverable content of ores, etc.)—thousand troy ounces	4,775	4,322	5,120	4,733	5,454	5,917	5,373	6,873
Stone—thousand short tons	4,249	5,107	3,582	4,626	4,333	6,616	3,257	5,069
Tungsten ore and concentrate—short tons, 60-percent WO_3 basis	(5)	(5)			15	14		
Uranium ore—short tons	283,684	6,219	228,225	4,965	143,196	3,047	150,584	4,844
Vanadium (recoverable in ore and concentrate)—do	(5)	(5)	(5)	(5)	632	(5)	222	(5)
Zinc (recoverable content of ores, etc.)—do	35,811	9,239	29,585	6,804	32,888	7,564	25,419	5,846
Value of items that cannot be disclosed: Asbestos, cement, clays (bentonite, fire clay 1961–63), diatomite (1961–63), feldspar, gypsum, helium (1961–62), iron ore (1961–63), scrap mica, perlite, pyrites, and values indicated by footnote 5		15,851		18,925		[6] 19,883		17,982
Total		417,225		425,995		[6] 474,131		481,392

Barite—short tons	277,851	$2,578	277,855	$2,630	258,691	$2,232	236,077	$2,161
Bauxite—long tons, dried equivalent	1,932,071	20,469	1,178,898	13,462	1,270,124	14,606	1,478,047	16,701
Clays—thousand short tons	815	2,456	773	1,758	654	1,693	769	1,763
Coal (bituminous)—do	409	3,116	395	2,888	256	1,809	221	1,505
Gem stones	(4)	38	(4)	19	(4)	15	(4)	42
Gypsum—thousand short tons	67	208	167	531	83	261	(5)	(5)
Iron ore (usable)—thousand long tons, gross weight					43	296	(5)	(5)
Lime—thousand short tons	(5)	(5)	90	1,196	350	4,542	167	2,237
Natural gas—million cubic feet	55,451	6,599	59,547	8,039	66,213	9,866	76,101	11,796
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	34,558	2,148	27,889	1,640	29,415	1,673	26,219	1,466
LP gases—do	73,252	3,735	75,157	3,286	69,452	2,432	66,377	2,497
Petroleum (crude)—thousand 42-gallon barrels	30,117	83,424	29,246	80,427	27,649	73,546	6 27,373	6 72,812
Sand and gravel—thousand short tons	8,192	10,262	9,389	9,074	10,847	10,006	12,099	13,589
Stone—do	10,939	13,555	12,029	12,402	20,611	19,866	18,913	22,727
Zinc (recoverable content of ores, etc.)—short tons	50	13	37	9	211	49		
Value of items that cannot be disclosed: Abrasive stones, bromine, cement, phosphate rock 1963, soapstone, and values indicated by footnote 5		10,918		10,906		11,063		17,900
Total		159,519		148,267		6 153,955		167,196

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
CALIFORNIA								
Asbestos—short tons	(5)	(5)	(5)	(5)	(5)	(5)	19,591	$1,547
Barite—do	16,157	$181	21,203	$295	6,945	$133	5,082	76
Boron minerals—do	640,591	47,550	602,613	46,936	646,613	49,336	700,183	54,981
Cement—thousand 376-pound barrels	[3] 39,712	[3] 128,826	[3] 41,090	[3] 129,836	43,667	139,151	46,278	147,656
Clays—thousand short tons	2,899	5,663	3,041	6,405	3,137	7,349	3,395	8,031
Copper (recoverable content of ores, etc.)—short tons	1,087	698	1,382	829	1,162	716	916	564
Feldspar—long tons	76,010	886	(5)	(5)	(5)	(5)	75,516	(5)
Gem stones	(4)	150	(4)	200	(4)	200	(4)	200
Gold (recoverable content of ores, etc.)—troy ounces	123,713	4,330	97,644	3,418	106,272	3,720	86,867	3,040
Gypsum—thousand short tons	1,616	3,687	1,574	3,733	1,747	4,113	1,756	4,222
Lead (recoverable content of ores, etc.)—short tons	440	103	103	21	455	84	823	178
Lime—thousand short tons	345	5,628	503	9,062	470	8,454	487	8,932
Magnesium compounds from sea water and bitterns (partly estimated) short tons, MgO equivalent	86,532	6,233	90,534	6,467	76,445	6,077	82,397	6,135
Manganiferous ore (5 to 35 percent Mn)—short tons, gross weight	96	(5)			(5)	(5)		
Mercury—76-pound flasks	18,764	3,955	18,688	3,693	15,951	3,050	13,592	2,575
Mica, scrap—short tons	(5)	(5)	950	12	(5)	(5)	977	14
Natural gas—million cubic feet	517,535	138,182	556,241	157,416	564,220	163,624	646,486	189,420
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	794,657	62,496	762,878	57,645	716,904	54,460	715,303	54,188
LP gases—do	408,378	21,482	424,767	21,805	407,378	19,294	393,503	17,329
Peat—short tons	33,091	481	46,348	501	33,901	331	39,873	450
Petroleum (crude)—thousand 42-gallon barrels	305,352	751,166	299,609	728,050	296,590	741,475	[6] 300,733	[6] 745,818
Pumice—thousand short tons	427	1,895	610	2,202	573	2,615	460	2,017
Salt—do	1,443	(5)	1,601	(5)	1,643	(5)	1,716	(5)
Sand and gravel—do	87,679	107,503	110,181	124,111	107,660	124,922	112,185	128,178
Silver (recoverable content of ores, etc.)—thousand troy ounces	180	163	93	86	133	144	157	200
Stone—thousand short tons	33,075	49,842	33,850	50,327	34,776	54,722	37,977	58,253
Sulfur ore—long tons	(5)	(5)	(5)	(5)	(5)	(5)	785	4
Talc, soapstone, and pyrophyllite—short tons	130,539	1,396	161,068	1,524	117,912	1,339	120,452	1,427
Wollastonite—do	(5)	(5)	4,075	42	(5)	(5)	3,000	28
Zinc (recoverable content of ores, etc.)—do	465	120	304	70	322	74	101	23
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, carbon dioxide, masonry cement (1960–61), coal (lignite), diatomite, fluorspar (1960–61), iodine, iron ore, lithium minerals, magnesite (1960–61), molybdenum, perlite, platinum-group metals (crude), potassium salts, pyrites, (1960–62), rare-earth metal concentrates, sodium carbonates and sulfates, tin (1963), tungsten concentrate, uranium ore (1960, 1963), and values indicated by footnote 5		79,471		81,051		81,957		89,873
Total		1,422,087		1,435,737		[8] 1,467,340		1,525,359

COLORADO

Beryllium concentrate	short tons, gross weight	304	$53	[11] 819	([5])	[11] 782	([5])	[11] 751	([5])
Carbon dioxide, natural	thousand cubic feet	155,871	20	167,872	$19	148,940	$15	224,856	$38
Clays	thousand short tons	490	1,424	556	1,241	802	1,573	686	1,334
Coal (bituminous)	do	3,607	21,090	3,678	22,787	3,379	19,999	3,690	21,888
Copper (recoverable content of ores, etc.)	short tons	3,247	2,085	4,141	2,485	4,534	2,793	4,169	2,568
Feldspar	long tons	([5])	([5])	14,129	99	([5])	([5])	([5])	([5])
Gem stones		([4])	45	([4])	36	([4])	45	([4])	63
Gold (recoverable content of ores, etc.)	troy ounces	61,269	2,144	67,515	2,363	48,882	1,711	33,605	1,176
Gypsum	thousand short tons	82	296	85	320	108	383	99	346
Iron ore (usable)	thousand long tons, gross weight	11	80	27	190	([5])	([5])	([5])	([5])
Lead (recoverable content of ores, etc.)	short tons	18,080	4,231	17,755	3,658	17,411	3,204	19,918	4,302
Lime	thousand short tons	([5])	([5])	75	1,319	93	1,518	128	2,104
Mica, scrap	short tons	340	4	600	10	142	2	440	7
Molybdenum (content of concentrate)	thousand pounds	51,615	65,448	47,485	63,582	32,412	45,376	47,977	67,168
Natural gas	million cubic feet	107,404	12,781	108,142	12,544	101,826	11,812	105,705	12,367
Natural gas liquids:									
Natural gasoline	thousand gallons	73,179	4,138	76,880	3,627	60,558	3,826	56,869	3,191
LP gases	do	104,275	4,938	115,410	5,498	100,787	4,411	91,309	4,171
Peat	short tons	9,384	37	9,894	44	12,351	68	13,774	98
Petroleum (crude)	thousand 42-gallon barrels	47,469	137,660	46,759	134,666	42,477	122,334	[6] 38,271	[6] 110,220
Pumice	thousand short tons	32	70	44	60	76	82	60	87
Sand and gravel	do	19,053	16,882	18,360	16,946	19,313	18,926	20,385	20,929
Silver (recoverable content of ores, etc.)	thousand troy ounces	1,659	1,502	1,965	1,817	2,088	2,265	2,307	2,951
Stone	thousand short tons	2,442	4,651	2,451	5,301	2,353	5,597	2,510	5,693
Tin (content of ore and concentrate)	long tons	10	12	([5])	([5])	([5])	([5])	([5])	([5])
Uranium ore	short tons	1,149,583	23,462	1,282,462	21,509	1,135,440	18,044	1,014,206	15,864
Vanadium (recoverable in ore and concentrate)	do	4,026	([5])	4,149	([4])	3,742	([5])	3,047	([5])
Vermiculite	thousand short tons					([5])	([5])	([12])	1
Zinc (recoverable content of ores, etc.)	short tons	31,278	8,070	42,647	9,809	43,351	9,971	48,109	11,065
Value of items that cannot be disclosed: Cement, fluorspar, perlite, pyrites, rare-earth and thorium concentrates (1960), salt, tungsten, and values indicated by footnote 5			34,295		36,278		34,209		29,478
Total			345,418		346,208		[6] 308,164		317,109

CONNECTICUT

Beryllium concentrate	short tons, gross weight	16	$9	2	$1	7	$4		
Clays	thousand short tons	207	308	[3] 149	[3] 260	[3] 179	[3] 287	189	$339
Gem stones		([4])	7	([4])	9	([4])	8	([4])	8
Lime	thousand short tons	35	616	33	589	35	635	35	666
Sand and gravel	do	6,575	5,960	7,499	6,633	10,208	9,244	10,503	9,343
Stone	do	5,057	8,313	5,206	8,616	5,090	8,816	5,318	9,612
Value of items that cannot be disclosed: Clays (kaolin 1961–62) feldspar, scrap mica (1961–63), sheet mica (1960–62), peat, and values indicated by footnote 5			140		491		760		646
Total			15,353		16,599		19,754		20,614

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
DELAWARE								
Clays thousand short tons	(5)	(5)	(5)	(5)	(5)	(5)	13	$13
Sand and gravel do	1,084	$907	961	$970	1,755	$1,445	1,094	1,136
Value of items that cannot be disclosed: Nonmetals		82		83		86		192
Total		989		1,053		1,531		1,341
FLORIDA								
Clays thousand short tons	[3] 252	[3] $6,357	513	$7,202	487	$6,741	538	$7,777
Lime do	151	2,611	(5)	(5)	(5)	(5)	126	1,996
Natural gas million cubic feet	30	5	29	5	29	6	35	7
Peat short tons	39,275	162	26,673	157	[3] 20,595	[3] 139	21,049	129
Petroleum (crude) thousand 42-gallon barrels	369	(5)	374	(5)	419	(5)	[6] 464	(5)
Phosphate rock thousand long tons	12,321	82,530	13,789	95,590	13,949	94,595	14,592	101,050
Sand and gravel thousand short tons	6,757	5,559	6,530	5,577	5,924	5,179	7,542	5,823
Stone do	[7] 27,629	[7] 37,419	[7] 26,221	[7] 33,671	27,279	32,608	31,900	38,173
Titanium concentrate thousand short tons, gross weight	286	7,489	(5)	(5)	(5)	(5)	(5)	(5)
Value of items that cannot be disclosed: Cement, clays (kaolin and miscellaneous clay 1960), gem stones (1960–61, 1963), magnesium compounds, natural gas liquids (1962–63), rare-earth metals concentrates (1961–63), staurolite, stone (dimension limestone 1961, calcareous marl 1960), zirconium concentrate, and values indicated by footnote 5		38,154		45,919		[8] 46,432		46,665
Total		180,286		188,121		[8] 185,700		201,620

GEORGIA

Barite	short tons	(5)	(5)	106,914	$2,046	108,829	$1,987	117,096	$2,013
Clays	thousand short tons	3,519	$40,160	3,569	42,025	3,801	47,462	4,208	54,024
Coal (bituminous)	do	4	21	4	22	8	28	5	16
Feldspar	long tons	(5)	(5)	31,128	692	35,692	795	(5)	(5)
Gem stones		(4)	(5)	(4)	(5)	(4)	(5)	(4)	1
Iron ore (usable)	thousand long tons, gross weight	128	613	162	835	215	1,118	260	1,304
Mica (sheet)	pounds	10,218	89	349	3	60	1		
Peat	short tons	6,904	73	1,914	(5)	(5)	(5)	(5)	(5)
Sand and gravel	thousand short tons	3,338	3,047	3,150	3,049	3,429	3,365	3,817	3,922
Stone	do	14,297	37,033	15,854	38,077	19,555	42,037	19,582	46,044
Talc	short tons	40,200	88	47,950	98	45,940	96	42,000	93
Value of items that cannot be disclosed: Bauxite, cement, gem stones, iron ore (pigment material, 1960), kyanite (1963), manganiferous ore, (1960–62), scrap mica, and values indicated by footnote 5			11,181		9,464		10,816		12,059
Total			92,305		96,311		107,705		119,476

HAWAII

Cement	thousand 376-pound barrels	113	$571	1,077	$5,574	1,128	$6,055	1,483	$7,125
Gem stones		(4)	(5)	(4)	18	(4)	(5)	(4)	36
Lime	thousand short tons	(5)	(5)	14	354	15	386	12	428
Pumice	do	361	676	324	626	232	380	274	469
Salt	do			(12)	4	(12)	(5)	(12)	(5)
Sand and gravel	do	490	1,324	416	758	700	1,122	304	764
Stone	do	3,535	6,443	4,429	7,656	4,071	6,883	3,844	6,480
Value of items that cannot be disclosed: Other nonmetals and values indicated by footnote 5			353				18		5
Total			9,367		14,990		14,844		15,307

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
IDAHO								
Antimony ore and concentrate—short tons, antimony content	635	(5)	689	(5)	631	(5)	645	(5)
Clays—thousand short tons	[3] 36	[3] $29	[3] 27	[3] $20	35	$70	[3] 31	[3] $15
Copper (recoverable content of ores, etc.)—short tons	4,208	2,702	4,328	2,597	3,861	2,378	4,172	2,570
Gold (recoverable content of ores, etc.)—troy ounces	6,135	215	5,718	200	5,845	205	5,477	192
Iron ore (usable)—thousand long tons, gross weight	9	(5)	12	70	5	35	6	40
Lead (recoverable content of ores, etc.)—short tons	42,907	10,040	71,476	14,724	84,058	15,467	75,759	16,364
Lime—thousand short tons			47	658	68	801	60	874
Mercury—76-pound flasks	1,538	324	1,073	212			(5)	(5)
Phosphate rock—thousand long tons	2,177	11,044	1,440	7,984	1,912	10,635	1,700	10,589
Pumice—thousand short tons	56	88	60	95	[4] 67	[5] 103	161	275
Sand and gravel—do	7,088	6,594	7,305	6,793	14,321	13,029	12,433	10,615
Silver (recoverable content of ores, etc.)—thousand troy ounces	13,647	12,351	17,576	16,249	17,772	19,283	16,711	21,375
Stone—thousand short tons	1,318	2,141	1,873	3,111	1,381	2,698	1,168	2,217
Titanium concentrate—short tons, gross weight	2,014	30	1,873	28	(5)	(5)	(5)	(5)
Zinc (recoverable content of ores, etc.)—short tons	36,801	9,495	58,295	13,408	62,865	14,459	63,267	14,551
Value of items that cannot be disclosed: Barite, cement, clays (fire clay 1960–61, 1963, bentonite 1960–61, 1963, kaolin 1961, 1963), abrasive garnet, gem stones, scrap mica (1963), sheet mica (1960, 1962), peat, perlite (1961–63), tungsten concentrate (1961), uranium (1960–62), vanadium (1961–63), and values indicated by footnote 5		2,553		2,885		3,451		3,078
Total		57,606		69,034		[6] 82,614		82,755

ILLINOIS

Cement:								
Portland—thousand 376-pound barrels	9,139	$30,732	8,595	$28,301	9,145	$30,205	9,281	$30,577
Masonry—thousand 280-pound barrels			461	1,420	440	1,320	472	1,440
Clays—thousand short tons	2,357	5,479	1,982	4,166	1,929	4,151	1,949	4,368
Coal (bituminous)—do	45,977	184,087	45,246	177,070	48,487	186,986	51,736	196,518
Fluorspar—short tons	134,529	6,936	116,908	5,956	132,830	6,392	132,060	6,547
Lead (recoverable content of ores, etc.)—do	3,000	702	3,430	707	3,610	664	2,901	627
Natural gas—million cubic feet	11,666	1,458	9,970	1,276	10,650	1,523	9,459	1,220
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	16,496	1,313	16,956	1,311	13,315	1,023	14,939	1,077
LP gases—do	358,366	19,941	340,284	16,495	327,616	13,812	337,278	14,714
Peat—short tons	6,179	28	6,597	30	(5)	(5)	(5)	(5)
Petroleum (crude)—thousand 42-gallon barrels	77,341	228,929	76,818	229,686	78,796	234,812	[6] 73,783	[6] 219,873
Sand and gravel—thousand short tons	33,138	36,255	31,353	35,098	34,122	38,981	31,746	36,431
Stone—do	41,721	55,593	36,361	47,939	41,293	54,411	40,293	52,217
Zinc (recoverable content of ores, etc.)—short tons	29,550	7,624	26,795	6,163	27,413	6,305	20,337	4,678
Value of items that cannot be disclosed: Gem stones, lime, tripoli, and values indicated by footnote 5		10,797		11,775		12,133		13,656
Total		589,874		567,393		[6] 592,718		583,943

INDIANA

Abrasive stones—short tons	(5)	(5)	5	$14	5	$15	5	$16
Cement [2]—thousand 376-pound barrels	14,052	$48,310	13,780	47,024	12,878	42,572	(5)	(5)
Clays—thousand short tons	1,822	3,396	1,362	2,446	1,450	2,255	1,546	2,347
Coal (bituminous)—do	15,538	61,570	15,106	58,815	15,709	60,079	15,100	57,120
Natural gas—million cubic feet	342	61	382	77	284	60	286	67
Peat—short tons	27,486	290	57,146	502	47,430	272	47,695	412
Petroleum (crude)—thousand 42-gallon barrels	12,054	35,439	11,500	34,270	12,077	35,989	[6] 11,417	[6] 33,794
Sand and gravel—thousand short tons	20,752	18,377	19,577	16,898	21,261	18,692	22,840	20,683
Stone—do	18,956	34,920	18,001	33,062	18,709	34,653	19,667	35,616
Value of items that cannot be disclosed: Cement (masonry 1960-61, 1963), gem stones (1961-63), gypsum, and values indicated by footnote 5		8,569		8,437		8,839		52,475
Total		210,932		201,545		[6] 203,426		202,530

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
IOWA								
Cement:								
Portland—thousand 376-pound barrels	12,517	$44,204	12,108	$41,718	12,261	$42,417	12,495	$42,891
Masonry—thousand 280-pound barrels			557	1,843	568	1,786	551	1,754
Clays—thousand short tons	1,022	1,345	1,044	1,426	1,039	1,427	1,064	1,405
Coal (bituminous)—do	1,068	3,845	927	3,323	1,130	4,026	1,213	4,244
Gypsum—do	1,283	5,428	1,239	5,276	1,256	5,318	1,282	5,667
Sand and gravel—do	14,692	13,516	13,391	11,651	13,797	12,474	14,168	12,845
Stone—do	23,185	30,321	22,018	28,916	21,618	28,244	20,904	27,788
Value of items that cannot be disclosed: Gem stones (1960–62), lime, peat, and petroleum		660		845		869		1,076
Total		99,319		94,998		96,561		97,670
KANSAS								
Cement:								
Portland—thousand 376-pound barrels	8,162	$26,373	8,028	$25,605	8,058	$25,134	8,201	$25,372
Masonry—thousand 280-pound barrels			379	1,156	392	1,156	387	1,133
Clays—thousand short tons	894	1,224	954	1,225	895	1,091	893	1,104
Coal (bituminous)—do	888	4,197	664	3,102	915	4,249	1,169	5,311
Helium—thousand cubic feet	21,696	350	23,251	434	42,305	1,478	46,177	1,616
Lead (recoverable content of ores, etc.)—short tons	781	183	1,449	298	970	178	1,027	222
Lime—thousand short tons			15	193	5	59		
Natural gas—million cubic feet	634,410	74,226	649,083	81,135	694,352	86,100	732,946	97,482
Natural gas liquids:								
Natural gasoline—thousand gallons	115,868	6,694	132,180	5,790	151,360	7,696	165,370	9,811
LP gases—do	127,270	6,343	135,643	5,916	166,769	6,295	395,877	15,481
Petroleum (crude)—thousand 42-gallon barrels	113,453	329,014	112,241	324,376	112,076	326,141	[6] 109,107	[6] 317,501
Salt—thousand short tons	1,213	14,109	[13] 913	[13] 11,409	[13] 944	[13] 11,654	[13] 924	[13] 11,993
Sand and gravel—do	9,710	6,808	11,366	7,781	11,552	8,039	12,062	8,676
Stone—do	[7] 11,814	[7] 15,031	[7] 12,328	[7] 16,411	[7] 13,527	[7] 17,274	13,558	18,483
Zinc (recoverable content of ores, etc.)—short tons	2,117	546	2,446	563	3,943	907	3,508	807
Value of items that cannot be disclosed: Natural cement, gem stones (1960), gypsum, pumice, salt (brine 1961–63), and stone (crushed sandstone 1960–62)		1,436		3,204		3,625		3,260
Total		486,534		488,598		501,076		518,302

KENTUCKY

Barite	short tons	(5)	(5)	3,304	$30	4,097	$36	5,812	$85
Clays [3]	thousand short tons	951	$2,646	906	2,406	936	2,158	984	2,397
Coal (bituminous)	do	66,846	282,395	63,032	256,158	69,212	270,875	77,350	295,743
Fluorspar	short tons	25,855	1,173	31,169	1,420	33,830	1,492	35,072	1,537
Lead (recoverable content of ores, etc.)	do	558	131	656	135	743	137	831	179
Natural gas	million cubic feet	75,329	18,380	70,937	17,592	70,241	17,419	74,634	17,838
Petroleum (crude)	thousand 42-gallon barrels	21,147	60,268	18,344	54,482	17,789	52,478	[6] 19,047	[6] 55,617
Sand and gravel	thousand short tons	5,113	5,763	5,582	5,540	6,137	5,378	6,480	6,071
Silver (recoverable content of ores, etc.)	thousand troy ounces			2	2	1	2	2	2
Stone	thousand short tons	[7] 15,810	[7] 21,493	17,085	23,309	19,472	27,682	24,689	34,571
Zinc (recoverable content of ores, etc.)	short tons	869	224	1,147	264	1,172	270	1,461	336
Value of items that cannot be disclosed: Cement, ball clay, gem stones, natural gas liquids, stone (crushed sandstone 1960), and values indicated by footnote 5			22,080		22,450		20,609		20,370
Total			414,553		383,788		[8] 398,536		434,746

LOUISIANA

Clays	thousand short tons	749	$749	645	$645	638	$641	655	$655
Lime	do	(5)	(5)	636	6,292	624	6,519	657	6,862
Natural gas	million cubic feet	2,988,414	511,019	3,271,857	611,837	3,525,456	694,515	3,928,427	777,829
Natural gas liquids:									
Natural gasoline and cycle products	thousand gallons	875,567	66,214	931,176	61,714	1,010,137	74,726	1,143,707	81,332
LP gases	do	606,023	28,147	806,559	33,214	862,772	29,037	1,113,670	41,043
Petroleum (crude)	thousand 42-gallon barrels	400,832	1,258,138	424,962	1,338,160	477,153	1,502,568	[6] 522,739	[6] 1,631,792
Salt	thousand short tons	4,792	21,959	4,722	23,357	5,248	27,407	6,199	30,450
Sand and gravel	do	14,319	19,106	12,042	14,833	12,040	14,817	12,500	14,701
Stone [7]	do	4,691	8,882	4,641	7,656	5,711	8,067	5,408	7,961
Sulfur (Frasch process)	thousand long tons	2,256	52,639	2,352	55,164	2,262	49,772	2,445	48,905
Value of items that cannot be disclosed: Cement, gypsum, stone (crushed miscellaneous), and values indicated by footnote 5			24,042		15,807		18,554		20,531
Total			1,990,895		2,168,679		[8] 2,426,623		2,662,061

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MAINE								
Beryllium concentrate—short tons, gross weight	[5]	[5]	5	$3	[5]	[5]		
Clays—thousand short tons	41	$50	43	51	48	$63	42	$55
Gem stones	[4]	15	[4]	20	[4]	25	[4]	25
Mica:								
Scrap—short tons	171	6	80	2	15	[10]		
Sheet—pounds	28,860	303	9,680	88	2,017	16		
Peat—short tons					[3] 1,250	47	[5]	[5]
Sand and gravel—thousand short tons	9,833	3,892	8,921	3,796	10,014	4,013	11,195	4,673
Stone—do	1,012	3,851	998	4,694	1,127	4,249	947	3,581
Value of items that cannot be disclosed: Cement, feldspar, and values indicated by footnote 5		5,991		6,961		6,534		5,770
Total		14,108		15,615		14,947		14,104
MARYLAND								
Clays—thousand short tons	[3] 612	[3] $853	581	$997	593	$899	580	$897
Coal (bituminous)—do	748	2,799	757	2,868	821	3,168	1,162	4,330
Gem stones	[4]	2	[4]	3	[4]	3	[4]	3
Natural gas—million cubic feet	4,065	1,081	3,578	973	2,472	667	1,633	439
Sand and gravel—thousand short tons	10,076	13,221	12,404	16,894	12,762	16,816	13,310	16,063
Stone—do	7,944	16,962	10,007	20,373	11,610	22,595	13,012	26,407
Value of items that cannot be disclosed: Cement, ball clay (1960), diatomite (1962-63), lime, greensand marl, peat (1961-63), potassium salts, and talc and soapstone		22,779		20,750		22,481		22,111
Total		57,697		62,858		66,629		70,250

MASSACHUSETTS

Clays—thousand short tons	83	$71	104	$85	125	$96	157	$213
Gem stones	(4)	1	(4)	2	(4)	2	(4)	2
Lime—thousand short tons	154	2,370	145	2,307	148	2,337	145	2,426
Sand and gravel—do	14,789	13,013	18,061	14,958	17,566	15,026	19,905	15,592
Stone—do	5,247	12,782	5,210	13,399	4,985	12,541	5,570	14,396
Value of items that cannot be disclosed: Nonmetals		8		38		33		32
Total		28,245		30,789		30,035		32,661

MICHIGAN

Cement:								
Portland—thousand 376-pound barrels	22,361	$77,694	21,948	$75,172	22,682	$73,267	25,016	$76,944
Masonry—thousand 280-pound barrels			1,515	4,467	1,517	4,335	1,684	4,519
Clays—thousand short tons	1,738	1,904	1,817	1,975	1,751	1,917	1,958	2,149
Copper (recoverable content of ores, etc.)—short tons	56,385	36,199	70,245	42,147	74,099	45,645	75,262	46,361
Gypsum—thousand short tons	1,463	5,609	1,295	5,095	1,278	4,791	1,315	4,938
Iron ore (usable)—thousand long tons, gross weight	10,792	95,791	9,384	87,604	9,422	85,597	10,789	107,201
Lime—thousand short tons	1,177	15,730	1,190	15,665	1,153	15,371	1,371	18,431
Magnesium compounds from sea water and brine (except for metal) short tons, MgO equivalent	(5)	(5)	(5)	(5)	(5)	(5)	266,740	23,062
Manganiferous ore (5 to 35 percent Mn)—short tons, gross weight	180,460	(5)	17,083	(5)			152,957	(5)
Natural gas—million cubic feet	20,790	4,449	27,697	5,844	28,987	6,174	32,850	8,902
Peat—short tons	214,402	2,755	210,376	2,009	257,693	2,277	251,809	2,413
Petroleum (crude)—thousand 42-gallon barrels	15,899	46,266	18,901	55,191	17,114	48,775	[6] 15,973	[6] 45,523
Salt—thousand short tons	4,088	33,759	3,885	31,284	4,274	33,343	4,244	33,656
Sand and gravel—do	46,910	39,304	54,603	47,790	47,563	42,029	50,458	43,433
Silver (recoverable content of ores, etc.)—thousand troy ounces					401	436	339	434
Stone—thousand short tons	31,256	32,274	28,731	30,103	28,440	29,055	30,316	32,065
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, gem stones, iodine (1961–63), natural gas liquids, potassium salts, and values indicated by footnote 5		45,864		46,306		53,500		42,001
Total		437,598		450,652		[6] 446,512		492,032

MINNESOTA

Clays—thousand short tons	[3] 125	[3] $163	[3] 176	[3] $241	203	$291	[3] 199	[3] $298
Iron ore (usable)—thousand long tons, gross weight	54,723	470,874	44,699	407,152	44,295	385,997	45,435	408,486
Manganiferous ore (5 to 35 percent Mn)—short tons, gross weight	441,028	(5)	181,835	(5)	292,779	(5)	347,336	(5)
Peat—short tons	1,465	72	11,091	181	[5] 14,386	307	8,110	294
Sand and gravel—thousand short tons	30,302	24,611	30,690	24,143	29,399	22,656	30,462	23,318
Stone—do	4,234	10,034	3,957	9,975	3,803	10,360	3,898	11,027
Value of items that cannot be disclosed: Abrasive stones, cement, fire clay (1960–61, 1963), gem stones, lime, and values indicated by footnote 5		9,767		9,222		9,325		10,120
Total		515,521		450,914		428,936		453,543

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MISSISSIPPI								
Clays—thousand short tons	1,017	$4,786	1,104	$5,034	1,129	$5,742	1,235	$5,968
Natural gas—million cubic feet	172,478	32,426	172,543	32,093	170,271	32,351	176,807	31,825
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	23,648	1,552	25,135	1,625	25,891	1,616	28,757	1,755
LP gases—do	10,151	564	15,510	700	20,401	732	24,541	956
Petroleum (crude)—thousand 42-gallon barrels	51,673	146,235	54,688	154,220	55,713	154,882	[6] 58,752	[6] 162,156
Sand and gravel—thousand short tons	6,181	5,568	5,920	5,903	7,001	7,262	6,825	7,056
Stone—do	807	808	913	1,044	1,199	1,266	1,267	1,267
Value of items that cannot be disclosed: Certain nonmetals		7,271		7,961		9,030		8,955
Total		199,210		208,580		[3] 212,881		219,938
MISSOURI								
Barite—short tons	180,702	$2,588	227,323	$3,052	303,945	$3,994	236,750	$3,680
Cement:								
Portland—thousand 376-pound barrels	12,183	42,330	11,839	41,142	12,739	44,004	12,402	41,640
Masonry—thousand 280-pound barrels			437	1,398	455	1,457	417	1,345
Clays—thousand short tons	2,540	7,207	2,132	5,040	2,053	5,033	1,746	4,467
Coal (bituminous)—do	2,890	12,450	2,938	12,567	2,896	12,057	3,174	13,196
Copper (recoverable content of ores, etc.)—short tons	1,087	698	1,479	887	2,752	1,695	1,816	1,119
Iron ore (usable)—thousand long tons, gross weight	365	3,760	341	3,633	346	3,188	345	3,085
Lead (recoverable content of ores, etc.)—short tons	111,948	26,196	98,785	20,350	60,982	11,221	79,844	17,246
Lime—thousand short tons	1,254	14,701	1,173	13,873	1,176	13,703	1,240	14,386
Natural gas—million cubic feet	75	19	90	22	92	23	100	27
Petroleum (crude)—thousand 42-gallon barrels	75	([5])	72	([5])	55	([5])	[6] 54	([5])
Sand and gravel—thousand short tons	10,207	11,601	9,371	10,688	10,304	11,572	10,653	12,260
Silver (recoverable content of ores, etc.)—thousand troy ounces	16	14	12	11	491	533	132	168
Stone—thousand short tons	27,180	37,878	25,631	36,577	28,876	44,006	30,885	46,130
Zinc (recoverable content of ores, etc.)—short tons	2,821	728	5,847	1,345	2,792	642	321	74
Value of items that cannot be disclosed: Native asphalt, cobalt (1960–61), gem stones, nickel (1960–61), and values indicated by footnote 5		2,074		703		179		168
Total		162,244		151,288		153,307		158,991

MONTANA

Chromite	short tons, gross weight	[14] 107,000	[14] $3,813	[14] 82,000	[14] $2,939			
Clays [2]	thousand short tons	63	77	55	76	56	$77	38	$45
Coal (bituminous and lignite)	do	313	1,188	371	1,207	382	1,140	343	967
Copper (recoverable content of ores, etc.)	short tons	91,972	59,046	104,000	62,400	94,021	57,917	79,762	49,133
Fluorspar	do	31,273	(5)	14,905	(5)	(5)	(5)	(5)	(5)
Gold (recoverable content of ores, etc.)	troy ounces	45,922	1,607	35,377	1,238	24,387	854	18,520	648
Iron ore (usable)	thousand long tons, gross weight	55	293	34	209	9	62	13	89
Lead (recoverable content of ores, etc.)	short tons	4,879	1,142	2,643	544	6,121	1,126	5,000	1,080
Lime	thousand short tons	(5)	(5)	118	986	104	1,049	114	1,290
Manganese ore (35 percent or more Mn)	short tons, gross weight	29,036	1,996	17,515	1,372	24,758	(5)	5,260	(5)
Manganiferous ore (5 to 35 percent Mn)	do	676	11	2,236	33	2,264	29	1,688	(5)
Natural gas	million cubic feet	33,418	2,373	33,901	2,509	29,955	2,217	30,026	2,253
Peat	short tons			7,385	112	(5)	(5)	(5)	(5)
Petroleum (crude)	thousand 42-gallon barrels	30,240	72,878	30,906	74,793	31,648	76,690	[6] 30,875	[6] 75,335
Sand and gravel	thousand short tons	12,589	11,657	14,702	13,506	18,473	17,642	14,319	13,756
Silver (recoverable content of ores, etc.)	thousand troy ounces	3,607	3,265	3,490	3,227	4,561	4,948	4,242	5,426
Stone	thousand short tons	1,183	1,576	1,512	1,849	996	1,708	6,109	7,081
Uranium ore	short tons	1,726	29	729	10	(5)	(5)	(5)	(10)
Zinc (recoverable content of ores, etc.)	do	12,551	3,238	10,262	2,360	37,678	8,666	32,941	7,576
Value of items that cannot be disclosed: Barite, cement, chromite,[14] clays (fire clay), gem stones, gypsum, sheet mica (1960–62), natural gas liquids, phosphate rock, rare-earth metal concentrates (1962), talc, tungsten (1960–62), vermiculite, and values indicated by footnote 5			15,217		14,863		16,531		17,348
Total			179,406		184,233		190,656		182,027

NEBRASKA

Clays	thousand short tons	108	$109	146	$148	142	$142	148	$148
Gem stones		(5)	4	(4)	5	(4)	5	(4)	5
Natural gas	million cubic feet	15,258	2,670	15,743	2,629	14,880	2,708	13,051	2,454
Natural gas liquids:									
Natural gasoline	thousand gallons	(5)	(5)	(5)	(5)	12,239	809	10,119	687
LP gases	do	(5)	(5)	(5)	(5)	28,718	1,329	25,931	1,207
Petroleum (crude)	thousand 42-gallon barrels	23,825	68,378	24,369	69,452	24,894	70,450	[6] 21,775	[6] 61,623
Sand and gravel	thousand short tons	10,876	8,746	10,094	8,250	12,853	9,797	11,166	10,680
Stone	do	3,336	5,651	3,622	6,324	3,670	6,626	3,700	6,192
Value of items that cannot be disclosed: Cement, lime (1961–63), pumice, and values indicated by footnote 5			18,384		18,637		16,507		15,710
Total			103,942		105,445		[8] 108,373		98,706

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NEVADA								
Barite—short tons	86,061	$591	129,524	$863	137,727	$954	120,450	$760
Copper (recoverable content of ores, etc.)—do	77,485	49,745	78,022	46,813	82,602	50,883	81,738	50,351
Fluorspar—do	18,505	388	18,129	357	[5]	[5]	[5]	[5]
Gem stones	[4]	100	[4]	100	[4]	100	[4]	100
Gold (recoverable content of ores, etc.)—troy ounces	58,187	2,037	54,165	1,896	62,863	2,200	98,879	3,461
Gypsum—thousand short tons	802	2,721	729	2,625	817	2,952	890	3,216
Iron ore (usable)—thousand long tons, gross weight	740	3,683	845	4,608	617	3,238	772	3,921
Lead (recoverable content of ores, etc.)—short tons	987	231	1,791	369	771	142	1,126	243
Manganese ore (35 percent or more Mn)—short tons, gross weight	49,076	3,301	28,573	1,852				
Mercury—76-pound flasks	7,821	1,648	7,486	1,480	6,573	1,257	4,944	937
Perlite—short tons	35,214	286	29,544	240	25,067	205	22,910	192
Petroleum (crude)—thousand 42-gallon barrels	27	[5]	154	[5]	141	[5]	[6] 96	[5]
Sand and gravel—thousand short tons	4,085	5,224	7,095	7,443	7,850	9,655	9,688	10,513
Silver (recoverable content of ores, etc.)—thousand troy ounces	707	640	388	359	245	266	215	275
Stone—thousand short tons	579	1,350	677	1,576	722	1,220	639	1,101
Sulfur ore—long tons	[5]	[5]	[5]	[5]	[5]	[5]	586	11
Talc and soapstone—short tons	4,882	30	3,090	33	6,157	55	4,243	50
Tungsten ore and concentrate—short tons, 60-percent WO_3 basis	[5]	[5]	[5]	[5]	156	234	[5]	[5]
Zinc (recoverable content of ores, etc.)—short tons	420	108	453	104	281	65	571	131
Value of items that cannot be disclosed: Clays, diatomite, lime, magnesite, manganiferous ore (1960), molybdenum, pumice, salt, uranium ore (1960–61, 1963), and values indicated by footnote 5		8,809		10,815		[8] 9,648		10,178
Total		80,892		81,533		[8] 83,074		85,440
NEW HAMPSHIRE								
Beryllium concentrate—short tons, gross weight	14	$8	23	$14	7	$4		
Clays—thousand short tons	27	27	30	30	37	37	110	$103
Feldspar—long tons	[5]	[5]	10,290	62	[5]	[5]	[5]	[5]
Gem stones	[4]	15	[4]	[5]	[4]	[5]	[4]	[5]
Mica:								
Sheet—pounds	80,077	1,026	105,943	1,009	[8] 37,508	[8] 396		
Scrap—short tons	415	14	669	20	411	11		
Peat—do	23	[5]	15	[5]				
Sand and gravel—thousand short tons	6,621	3,687	7,701	3,627	8,260	4,119	7,581	4,376
Stone—do	104	594	117	684	154	1,368	137	1,566
Value of items that cannot be disclosed: Values indicated by footnote 5		68		20		97		109
Total		5,439		5,466		[8] 6,032		6,154

NEW JERSEY

Clays	thousand short tons	664	$1,597	657	$1,681	584	$1,476	498	$1,392
Gem stones		(4)	7	(4)	9	(4)	9	(4)	9
Peat	short tons	25,100	192	21,257	212	[3] 29,099	247	23,685	241
Sand and gravel	thousand short tons	11,594	19,511	12,257	20,895	13,728	21,230	16,672	25,245
Stone	do	10,202	22,814	11,315	24,539	14,214	28,979	11,229	25,654
Zinc (recoverable content of ores, etc.) [15]	short tons			112	26	15,309	3,559	32,738	7,855
Value of items that cannot be disclosed: Iron ore, lime, magnesium compounds, manganiferous residuum, greensand marl, titanium concentrate (ilmenite 1962–63) uranium ore (1960)			12,348		11,908		10,186		12,880
Total			56,469		59,270		65,686		73,276

NEW MEXICO

Barite	short tons	492	$10	600	$10	252	$4	600	$6
Beryllium concentrate	short tons, gross weight			24	12	34	19		
Carbon dioxide, natural	thousand cubic feet	230,115	(5)	242,903	24	826,810	74	854,339	63
Clays	thousand short tons	[3] 56	[3] 132	[3] 67	[3] 165	52	156	(5)	140
Coal (bituminous)	do	295	1,747	412	2,477	677	2,595	1,945	5,629
Copper (recoverable content of ores, etc.)	short tons	67,288	43,199	79,606	47,764	82,683	50,933	83,037	51,151
Gem stones		(4)	40	(4)	46	(4)	45	(4)	45
Gold (recoverable content of ores, etc.)	troy ounces	5,423	190	6,201	217	7,529	264	7,805	273
Gypsum	thousand short tons	55	193	105	386	151	564	179	656
Helium	thousand cubic feet	43,494	684	42,224	762	27,377	958	79,624	2,787
Iron ore (usable)	thousand long tons, gross weight	1	27	(16)	(5)	9	121	(5)	(5)
Lead (recoverable content of ores, etc.)	short tons	1,996	467	2,332	480	1,134	209	1,014	219
Lime	thousand short tons	36	496	25	350	29	403	27	377
Manganiferous ore (5 to 35 percent Mn)	short tons, gross weight	(5)	(5)	(5)	(5)	(5)	(5)	41,144	242
Mica: Scrap	short tons	235	7	1,800	52	5,731	140	(5)	(5)
Natural gas	million cubic feet	798,928	85,485	789,662	86,073	804,612	92,530	808,377	96,197
Natural gas liquids:									
Natural gasoline and cycle products	thousand gallons	321,667	20,412	301,404	18,619	273,969	16,775	291,388	17,555
LP gases	do	645,116	28,788	656,751	24,154	661,330	20,359	728,200	21,801
Perlite	short tons	240,593	2,119	245,654	2,159	258,164	2,143	259,113	2,212
Petroleum (crude)	thousand 42-gallon barrels	107,380	305,895	112,553	322,142	109,328	314,883	[6] 109,613	[6] 315,632
Potassium salts	thousand short tons, K_2O equivalent	2,440	82,645	2,523	96,380	2,208	85,124	2,644	100,570
Pumice	thousand short tons	365	827	339	879	308	741	322	850
Salt	do	39	331	33	284	43	334	57	518
Sand and gravel	do	7,419	7,459	12,523	10,049	6,889	8,021	8,402	12,843
Silver (recoverable content of ores, etc.)	thousand troy ounces	304	275	283	261	302	327	256	328
Stone	thousand short tons	1,277	1,692	1,853	2,206	2,004	2,782	2,509	4,236
Uranium ore	short tons	3,793,494	61,827	3,631,036	62,482	3,478,238	63,504	2,304,577	41,372
Vanadium (recoverable in ore and concentrate)	do	(5)	(5)	(5)	(5)	(5)	(5)	23	(5)
Zinc (recoverable content of ores, etc.)	do	13,770	3,553	22,900	5,267	22,015	5,063	12,938	2,976
Value of items that cannot be disclosed: Cement, fire clay (1960–61), molybdenum, magnesium compounds (1960–61), manganese ore, (1962–63), sheet mica (1960, 1962), vanadium, and values indicated by footnote 5			5,266		7,213		6,743		8,144
Total			653,766		690,913		[3] 675,814		686,822

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NEW YORK								
Clays.....thousand short tons	1,172	$1,717	1,037	$1,373	1,397	$1,618	1,598	$2,186
Emery.....short tons	8,169	142	6,180	106	4,316	71	6,732	119
Gem stones	(4)	9	(4)	10	(4)	10	(4)	10
Gypsum.....thousand short tons	755	3,928	663	3,441	601	3,122	647	3,339
Iron ore, (usable).....thousand long tons, gross weight	2,484	32,977	1,973	25,548	2,099	24,953	(5)	(5)
Lead (recoverable content of ores, etc.).....short tons	775	181	879	181	1,063	196	1,009	218
Natural gas.....million cubic feet	4,990	1,542	5,742	1,694	4,262	1,198	3,962	1,169
Peat.....short tons	10,042	146	11,209	123	[3] 14,400	113	21,358	178
Petroleum (crude).....thousand 42-gallon barrels	1,813	8,412	1,658	7,892	1,589	7,309	[6] 1,929	[6] 8,854
Salt.....thousand short tons	4,008	30,763	4,149	30,761	4,456	32,236	4,782	34,228
Sand and gravel.....do	30,687	35,152	28,043	30,471	29,447	31,346	37,381	37,274
Silver (recoverable content of ores, etc.).....thousand troy ounces	49	45	41	37	19	21	20	25
Stone.....thousand short tons	29,802	46,955	26,951	43,734	27,589	47,256	26,611	44,549
Zinc (recoverable content of ores, etc.).....short tons	66,364	17,122	54,763	12,595	53,654	12,340	53,495	12,304
Value of items that cannot be disclosed: Beryllium concentrate (1960–61), cement, abrasive garnet, lime, talc, titanium concentrate, wollastonite, and values indicated by footnote 5	----------	81,831	----------	75,867	----------	79,183	----------	115,768
Total	----------	260,922	----------	233,833	----------	[3] 240,972	----------	260,221

NORTH CAROLINA

Abrasive stones (millstones)	short tons	[4]	$2	[4]	$3	[4]	$2	[4]	$2
Clays [3]	thousand short tons	2,476	1,548	2,603	1,669	2,731	1,782	2,735	1,761
Feldspar	long tons	270,761	2,781	251,858	2,477	244,708	2,373	267,654	2,821
Gem stones		[4]	4	[4]	6	[4]	2	[4]	14
Gold (recoverable content of ores, etc.)	troy ounces	1,826	64	2,094	73	460	16	33	1
Iron ore (usable)	thousand long tons	[5]	[5]	[5]	1	1	13	1	10
Lead (recoverable content of ores, etc.)	short tons	424	99	318	66	219	40	62	13
Mica:									
Scrap	do	47,281	1,100	53,615	1,010	61,983	1,384	61,598	1,497
Sheet	pounds	436,579	1,539	390,870	2,237	320,305	867	92,961	13
Sand and gravel	thousand short tons	8,801	7,453	9,779	8,467	12,516	11,457	11,028	10,132
Silver (recoverable content of ores, etc.)	thousand troy ounces	212	192	170	157	100	109	27	34
Stone	thousand short tons	14,721	23,296	15,921	25,262	19,308	29,533	15,701	25,683
Talc and pyrophyllite	short tons	100,593	549	90,711	367	100,298	433	106,652	446
Zinc (recoverable content of ores, etc.)	do							13	3
Value of items that cannot be disclosed: Asbestos, barite (1961), cement (1963), clay (kaolin), copper, lithium minerals, olivine, tungsten concentrate, and values indicated by footnote 5			6,469		8,329		6,586		2,464
Total			45,096		50,124		54,597		44,894

NORTH DAKOTA

Clays	thousand short tons	[3] 102	[3] $129	[5]	[5]	98	$124	[3] 5	[3] $10
Coal (lignite)	do	2,525	5,790	2,726	$6,141	2,733	6,135	2,399	5,250
Gem stones		[4]	1	[4]	1	[4]	1	[4]	1
Natural gas	million cubic feet	19,483	2,221	20,100	2,533	25,155	3,446	32,798	6,264
Natural gas liquids:									
Natural gasoline	thousand gallons	[5]	[5]	[5]	[5]	16,872	1,085	20,511	1,339
LP gases	do	[5]	[5]	[5]	[5]	68,881	2,665	79,653	3,166
Petroleum (crude)	thousand 42-gallon barrels	21,992	59,598	23,652	64,333	25,181	69,248	[6] 24,957	[6] 68,133
Sand and gravel	thousand short tons	8,648	6,904	9,395	7,507	9,615	7,122	9,529	9,193
Stone	do	28	44	40	40	19	19	132	132
Uranium ore	short tons					[5]	[5]	5,567	141
Value of items that cannot be disclosed: Clays (bentonite 1960, 1963, fire clay 1960, miscellaneous clay 1963), peat (1963), salt, and values indicated by footnote 5			3,691		4,370		774		875
Total			78,378		84,925		[3] 90,619		94,504

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
OHIO								
Cement:								
Portland—thousand 376-pound barrels	17,480	$61,478	15,303	$53,251	15,353	$51,006	16,218	$53,244
Masonry—thousand 280-pound barrels			846	2,604	946	2,793	1,023	3,084
Clays—thousand short tons	5,165	14,325	4,923	13,790	4,751	12,979	4,841	13,959
Coal (bituminous)—do	33,957	130,877	32,226	121,343	34,125	127,051	36,790	136,113
Gem stones	(4)	3	(4)	4	(4)	3	(4)	3
Lime—thousand short tons	3,117	44,403	3,048	41,266	3,102	43,792	3,207	45,957
Natural gas—million cubic feet	36,074	8,477	36,423	9,069	36,747	9,407	36,817	8,909
Peat—short tons	6,755	93	9,113	123	7,383	106	6,910	109
Petroleum (crude)—thousand 42-gallon barrels	5,405	16,053	5,639	17,425	5,835	18,089	[6] 6,171	[6] 19,439
Salt—thousand short tons	3,108	24,149	3,465	25,037	4,187	28,706	4,245	29,682
Sand and gravel—do	37,943	44,979	33,688	41,272	35,204	43,333	37,790	44,368
Stone—do	[7] 35,856	[7] 59,479	33,652	55,701	34,470	57,202	37,537	62,787
Value of items that cannot be disclosed: Abrasive stones, gypsum, stone (dimension limestone 1960, calcareous marl 1960)		1,826		1,566		1,588		1,742
Total		406,142		382,451		[8] 396,055		419,396
OKLAHOMA								
Clays [3]—thousand short tons	734	$739	792	$801	737	$756	898	$911
Coal (bituminous)—do	1,342	9,113	1,032	6,784	1,048	6,978	1,008	5,667
Gypsum—do	(5)	(5)	(5)	(5)	509	1,668	531	1,462
Helium—thousand cubic feet	289,068	4,691	313,244	5,872	284,214	9,917	237,201	8,302
Lead (recoverable content of ores, etc.)—short tons	936	219	980	202	2,710	499	3,192	689
Natural gas—million cubic feet	824,266	98,088	892,697	108,016	1,060,717	135,772	1,233,883	160,405
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	531,995	33,074	521,237	33,358	552,795	35,764	555,467	35,131
LP gases—do	762,258	32,409	817,082	30,141	838,903	25,223	810,894	28,981
Petroleum (crude)—thousand 42-gallon barrels	192,913	563,306	193,081	561,866	202,732	591,977	[6] 200,238	[6] 582,693
Salt—thousand short tons	3	16	3	19	5	25	4	26
Sand and gravel—do	6,424	7,468	5,310	5,513	4,436	4,736	5,420	6,116
Stone—do	[7] 14,054	[7] 16,098	14,981	16,561	14,666	18,819	13,817	16,160
Zinc (recoverable content of ores, etc.)—short tons	2,332	602	3,148	724	10,013	2,303	13,245	3,046
Value of items that cannot be disclosed: Native asphalt (1960), clay (bentonite), cement, gem stones (1960–62), lime, pumice, stone (crushed granite 1960), tripoli, and values indicated by footnote 5		16,756		21,920		20,853		22,929
Total		782,579		791,777		[8] 855,290		872,518

OREGON

Clays	thousand short tons	318	$370	294	$357	249	$305	279	$330
Copper (recoverable content of ores, etc.)	short tons	6	4	(5)	(5)	(5)	(5)	(5)	(5)
Diatomite	do					50	2	150	3
Gold (recoverable content of ores, etc.)	troy ounces	835	29	1,054	37	822	29	1,809	63
Lime	thousand short tons	(5)	(5)	82	1,702	78	1,514	87	1,835
Mercury	76-pound flasks	513	108	138	27	(5)	(5)	(5)	(5)
Nickel (content of ore and concentrate)	short tons	13,115	5,246	12,860	(5)	13,110	(5)	13,394	(5)
Perlite	do					3	(16)		
Pumice	thousand short tons	(5)	(5)	203	461	(5)	(5)	422	664
Sand and gravel	do	17,673	16,170	12,299	13,680	14,869	14,556	15,715	18,850
Silver (recoverable content of ores, etc.)	thousand troy ounces	(17)	(16)	2	2	6	7	58	74
Stone	thousand short tons	16,913	19,721	17,455	21,202	18,258	20,977	19,692	24,197
Uranium ore	short tons	(5)	(5)	2,160	66	2,722	112	1,763	45
Zinc (recoverable content of ores, etc.)	do			3	1			3	1
Value of items that cannot be disclosed: Asbestos (1960–61), carbon dioxide (1960), cement, gem stones, iron ore (pigment material 1961, 1963), lead (1961, 1963), and values indicated by footnote 5			14,124		15,557		14,956		16,630
Total			55,772		53,092		52,458		62,692

PENNSYLVANIA

Cement:								
Portland	thousand 376-pound barrels	38,320	$131,763	36,635	$124,506	38,463	$127,969	38,316	$118,203
Masonry	thousand 280-pound barrels			2,678	7,232	2,565	7,105	2,510	6,611
Clays [3]	thousand short tons	3,557	16,536	2,999	14,402	2,893	12,815	3,191	14,717
Coal:									
Anthracite	do	18,817	147,116	17,446	140,338	16,894	134,094	18,267	153,503
Bituminous	do	65,425	345,971	62,652	323,758	65,315	331,298	71,501	350,085
Copper (recoverable content of ores, etc.)	short tons	(5)	(5)	(5)	(5)	(5)	(5)	4,434	2,731
Gem stones		(4)	4	(4)	5	(4)	4	(4)	4
Lime	thousand short tons	1,120	16,277	1,093	16,428	1,104	16,647	1,188	17,548
Natural gas	million cubic feet	113,928	36,229	100,427	29,526	90,053	24,494	92,657	24,091
Natural gas liquids:									
Natural gasoline	thousand gallons	1,399	85	1,272	74	1,350	75	1,311	78
LP gases	do	1,580	138	1,453	115	1,521	112	1,721	118
Peat	short tons	30,837	325	27,993	291	32,936	369	33,952	339
Petroleum (crude)	thousand 42-gallon barrels	6,009	27,341	5,643	26,579	5,302	24,230	[6] 4,963	[6] 22,631
Sand and gravel	thousand short tons	13,011	21,204	12,594	19,766	14,419	23,587	14,066	23,539
Stone	do	42,136	74,168	41,834	71,344	48,144	82,087	49,536	83,450
Zinc (recoverable content of ores, etc.) [15]	short tons	13,746	3,559	23,428	5,408	24,308	5,652	27,389	6,572
Value of items that cannot be disclosed: Clays (kaolin), cobalt, gold, graphite (1960–61), iron ore, scrap mica, pyrites, pyrophyllite, silver, tripoli, and values indicated by footnote 5			17,430		25,355		32,966		32,644
Total			838,146		805,127		[8] 823,504		856,864

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
RHODE ISLAND								
Gem stones								$1
Sand and gravel thousand short tons	1,535	$1,355	(4) 1,726	(5) $1,666	(4) 2,346	(5) $1,890	(4) 1,750	1,838
Stone do	1,810	4,372	(5)	(5)	[7] 304	[7] 483	442	968
Value of items that cannot be disclosed: Nonmetals and values indicated by footnote 5				1,413		621		
Total		5,727		3,079		2,994		2,807
SOUTH CAROLINA								
Clays thousand short tons	1,297	$6,201	1,346	$6,169	1,518	$7,165	1,491	$7,589
Mica (sheet) pounds	101	1	12	(10)				
Sand and gravel thousand short tons	3,029	3,048	2,904	3,067	3,318	3,670	4,051	4,750
Stone do	7,327	10,593	6,752	9,827	6,382	10,066	7,262	10,926
Value of items that cannot be disclosed: Barite, cement, feldspar, gem stones (1962–63), kyanite, scrap mica, peat, pyrites, and vermiculite		11,144		12,311		13,000		13,214
Total		30,987		31,374		33,901		36,479

Beryllium concentrate	short tons, gross weight	167	$88	238	$130	144	$77	(9)	(10)
Cement:									
Portland	thousand 376-pound barrels	(5)	(5)	(5)	(5)	2,316	7,369	(5)	(5)
Masonry	thousand 280-pound barrels	(5)	(5)	(5)	(5)	60	197	(5)	(5)
Clays	thousand short tons	[3] 202	[3] 202	[3] 249	[3] 249	249	690	315	$1,958
Coal (lignite)	do	20	83	18	75	18	77	16	62
Copper (recoverable content of ores, etc.)	short tons	1	1					1	(10)
Feldspar	long tons	45,588	292	29,354	186	29,697	191	25,590	[9] 157
Gem stones		(4)	20	(4)	18	(4)	20	(4)	20
Gold (recoverable content of ores, etc.)	troy ounces	554,771	19,417	557,855	19,525	577,232	20,203	576,726	20,185
Gypsum	thousand short tons	22	89	22	89	23	93	24	97
Iron ore (usable)	thousand long tons	(5)	(5)	22	100	34	113		
Lead (recoverable content of ores, etc.)	short tons					3	1	4	1
Mica:									
Scrap	short tons	205	10	1,054	32	210	6	(5)	(5)
Sheet	pounds	30,887	145	18,086	37	2,085	12	10,000	(10)
Petroleum (crude)	thousand 42-gallon barrels	281	(5)	233	(5)	169	(5)	[6] 187	(5)
Sand and gravel	thousand short tons	13,548	9,359	11,324	7,336	15,371	9,207	20,806	16,313
Silver (recoverable content of ores, etc.)	thousand troy ounces	108	98	127	118	113	123	117	150
Stone	thousand short tons	3,149	7,909	2,806	6,642	2,852	6,533	2,794	7,339
Uranium ore	short tons	41,104	586	43,588	495	29,452	370	72,088	1,931
Value of items that cannot be disclosed: Clays (bentonite 1960–61), lime, lithium minerals (1960, 1962–63), vanadium, and values indicated by footnote 5			9,376		8,975		[8] 505		6,845
Total			47,675		44,007		[8] 45,787		55,058

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
TENNESSEE								
Barite—short tons	(5)	(5)	(5)	(5)	13,797	$229	24,082	$404
Cement:								
Portland—thousand 376-pound barrels	8,246	$27,384	8,357	$26,964	8,509	27,741	8,283	26,760
Masonry—thousand 280-pound barrels	1,270	4,537	1,018	2,753	1,089	2,931	1,161	3,079
Clays—thousand short tons	5,930	21,154	[3] 1,040	[3] 4,190	[3] 1,037	[3] 4,597	[3] 1,238	[3] 5,248
Coal (bituminous)—do	12,723	8,168	5,860	20,681	6,214	22,555	6,121	22,689
Copper (recoverable content of ores, etc.)—short tons	(4)	1	12,272	7,363	14,298	8,808	13,717	8,450
Gem stones	123	4	(4)	1	(4)	1	(4)	(10)
Gold (recoverable content of ores, etc.)—troy ounces	283	15	152	5	158	6	137	5
Lead (recoverable content of ores, etc.)—short tons	63	11	71	13	51	9		
Manganese ore (35 percent or more Mn)—short tons, gross weight	20	(5)	17	(5)	75	14	90	17
Natural gas—million cubic feet	1,939	15,424	2,235	18,675	14	(5)	[3] 15	(5)
Petroleum (crude)—thousand 42-gallon barrels	6,293	7,655	6,232	8,046	2,418	19,868	2,352	17,876
Phosphate rock—thousand long tons	65	58	83	77	6,075	8,018	7,613	9,443
Sand and gravel—thousand short tons	20,074	29,942	23,940	35,906	112	122	108	138
Silver (recoverable content of ores, etc.)—thousand troy ounces	91,394	23,579	81,734	18,799	24,398	35,614	26,825	38,113
Stone—thousand short tons					71,548	16,456	95,847	22,045
Zinc (recoverable content of ores, etc.)—short tons								
Value of items that cannot be disclosed: Clay (fuller's earth 1961–63), iron ore, lime, manganiferous ore (1960), scrap mica (1960), pyrites, and values indicated by footnote 5		7,606		7,238		[3] 7,050		6,456
Total		145,538		150,711		[3] 154,019		160,723

Cement:								
Portland—thousand 376-pound barrels	23,365	$76,577	25,101	$80,808	26,204	$83,162	29,104	$92,734
Masonry—thousand 280-pound barrels			851	2,529	926	2,774	930	2,858
Clays[3]—thousand short tons	3,302	5,058	3,786	5,737	3,744	5,634	4,199	6,849
Gem stones	(4)	100	(4)	150	(4)	150	(4)	150
Gypsum—thousand short tons	1,131	3,960	1,074	3,832	1,120	3,956	1,099	3,999
Helium—thousand cubic feet	120,921	2,044	173,066	3,196	245,623	8,552	264,342	9,252
Lime—thousand short tons	821	9,087	[5] 790	8,703	1,046	11,999	1,131	13,026
Natural gas—million cubic feet	5,892,704	665,876	5,963,605	733,523	6,080,210	747,866	6,205,034	775,629
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	2,880,906	207,583	3,111,427	214,279	3,205,517	233,345	3,320,416	218,975
LP gases—do	4,476,142	200,478	4,768,222	185,558	5,012,291	189,382	5,366,831	169,695
Petroleum (crude)—thousand 42-gallon barrels	927,479	2,748,735	939,191	2,791,377	943,328	2,818,709	[6] 973,097	[6] 2,893,990
Salt—thousand short tons	4,756	18,222	4,695	17,682	5,553	19,485	5,965	22,355
Sand and gravel—do	29,844	30,754	27,398	30,691	30,076	33,097	33,256	36,311
Stone—do	39,029	45,088	38,316	45,874	38,067	48,988	43,142	54,007
Sulfur (Frasch process)—thousand long tons	2,747	62,855	2,730	62,720	2,655	57,297	2,550	50,109
Talc and soapstone—short tons	67,031	336	78,214	376	73,635	387	72,658	368
Value of items that cannot be disclosed: Native asphalt, barite (1961–63), bromine, clay (fuller's earth), coal (lignite), feldspar (1960–61), graphite, iron ore, magnesium chloride (for metal), magnesium compounds (except for metal), mercury (1960), pumice (1961–63), sodium sulfate, and uranium ore		49,666		50,923		58,774		62,777
Total		4,126,419		4,237,958		[6] 4,323,557		4,413,084

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
UTAH								
Asphalt and related bitumens, native: Gilsonite—short tons	383,037	$10,020	(6)	(6)	(6)	(6)	(6)	(6)
Carbon dioxide, natural—thousand cubic feet	60,425	4	78,136	$5	81,920	$6	100,895	$7
Clays—thousand short tons	[3] 143	[3] 416	143	1,080	174	1,403	[3] 125	[3] 470
Coal (bituminous)—do	4,955	31,458	5,159	31,126	4,297	23,209	4,360	22,755
Copper (recoverable content of ores, etc.)—short tons	218,049	139,987	213,534	128,120	218,018	134,299	203,095	125,107
Fluorspar—do	1,912	51	610	18	399	12	247	7
Gem stones	(6)	72	(4)	73	(4)	75	(4)	75
Gold (recoverable content of ores, etc.)—troy ounces	368,255	12,889	342,988	12,005	311,924	10,917	285,907	10,007
Iron ore (usable)—thousand long tons, gross weight	3,334	23,862	3,533	25,493	2,630	18,242	1,881	12,900
Lead (recoverable content of ores, etc.)—short tons	39,398	9,219	40,894	8,424	38,199	7,029	45,028	9,726
Lime—thousand short tons	127	2,672	142	2,626	163	2,759	156	2,668
Natural gas—million cubic feet	51,040	9,187	57,175	8,976	74,128	12,454	77,122	14,036
Perlite—short tons	(6)	(6)	(6)	(6)	929	3	1,313	7
Petroleum (crude)—thousand 42-gallon barrels	37,594	103,008	33,118	91,075	31,029	85,019	[3] 33,471	91,041
Pumice—thousand short tons	60	134	60	95	28	46	28	46
Salt—do	231	3,092	249	3,187	311	3,349	325	3,462
Sand and gravel—do	6,848	6,182	18,325	16,979	19,941	20,954	11,709	10,408
Silver (recoverable content of ores, etc.)—thousand troy ounces	4,783	4,329	4,798	4,435	4,628	5,022	4,791	6,128
Stone—thousand short tons	1,837	3,087	1,808	3,219	2,118	3,865	2,346	4,040
Uranium ore—short tons	1,089,757	27,843	1,098,783	25,734	781,955	23,653	743,792	23,852
Vanadium (recoverable in ore and concentrate)—do	462	(6)	514	(6)	525	(6)	382	(6)
Zinc (recoverable content of ores, etc.)—do	35,476	9,153	37,239	8,565	34,313	7,892	36,179	8,321
Value of items that cannot be disclosed: Barite (1960–62), cement, clay (kaolin 1960, 1963, fire clay 1963), gypsum, molybdenum, natural gas liquids, phosphate rock, potassium salts, pyrites (1960), and values indicated by footnote 5		36,047		45,554		50,382		40,458
Total		432,712		416,789		[3] 410,590		385,521
VERMONT								
Gem stones	(4)	$1	(4)	$2	(4)	$2	(4)	(5)
Sand and gravel—thousand short tons	1,809	1,218	2,232	1,567	1,430	1,076	2,375	$1,410
Stone—do	2,114	17,444	2,731	18,715	1,715	19,815	2,159	19,193
Value of items that cannot be disclosed: Asbestos, clays, lime, talc, and values indicated by footnote 5		4,240		4,012		4,237		3,788
Total		22,903		24,296		25,130		24,391

VIRGINIA

Aplite	long tons	(5)	(5)	97,465	$651	125,156	$912	(5)	(5)
Clays	thousand short tons	1,348	$1,395	1,406	1,332	1,464	1,444	1,410	$1,558
Coal (bituminous)	do	27,838	122,723	30,332	126,121	29,474	117,560	30,531	120,972
Gem stones		(4)	5	(4)	6	(4)	6	(4)	6
Lead (recoverable content or ores, etc.)	short tons	2,152	504	3,733	769	4,059	747	3,500	756
Lime	thousand short tons	711	8,028	657	7,375	615	7,668	639	8,058
Mica, sheet	pounds	103	1	(5)	(5)				
Natural gas	million cubic feet	2,227	604	2,466	668	2,499	677	2,085	488
Petroleum (crude)	thousand 42-gallon barrels	2	(5)	2	(5)	3	(5)	[6] 3	(5)
Sand and gravel	thousand short tons	7,666	11,432	9,839	14,697	9,745	16,375	10,400	17,752
Soapstone	short tons	(5)	(5)	(5)	(5)	(5)	(5)	3,696	9
Stone	thousand short tons	19,358	33,019	22,934	39,206	25,766	43,121	27,653	45,529
Zinc (recoverable content of ores, etc.) [15]	short tons	19,885	5,142	29,163	6,726	26,479	6,141	23,988	5,725
Value of items that cannot be disclosed: Cement, feldspar, gypsum, iron ore (pigment materials), kyanite, pyrites (1960–62), salt, titanium concentrate, and values indicated by footnote 5			26,027		27,747		27,843		28,212
Total			208,880		225,298		222,494		229,065

WASHINGTON

Abrasive stone (grinding pebbles)	short tons	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(10)
Barite	do	(5)	(5)	5,100	$42	(5)	(5)		
Clays [3]	thousand short tons	169	$162	145	138	103	$100	134	$123
Coal (bituminous)	do	228	1,721	191	1,381	235	1,630	190	1,380
Copper (recoverable content of ores, etc.)	short tons	78	50	66	40	41	25	(5)	(5)
Lead (recoverable content or ores, etc.)	do	7,725	1,808	8,053	1,659	6,033	1,110	5,374	1,161
Peat	do	27,770	121	57,393	363	[8] 41,962	288	37,248	188
Petroleum (crude)	thousand 42-gallon barrels	1	(5)	(18)	(10)				
Pumice	thousand short tons	(5)	(5)	(5)	(5)	10	130	(5)	(5)
Sand and gravel	do	25,594	19,459	18,994	16,145	19,580	18,145	22,760	20,490
Stone	do	13,897	15,796	11,464	14,758	12,749	18,180	12,934	16,346
Talc and soapstone	short tons	2,406	12	2,927	23	2,835	11	2,969	18
Uranium ore	do	171,255	3,223	175,327	3,582	110,948	2,050	117,286	2,545
Zinc (recoverable content of ores, etc.)	do	21,317	5,500	20,217	4,650	21,644	4,978	22,270	5,122
Value of items that cannot be disclosed: Carbon dioxide, cement, clays (fire clay, bentonite 1961), diatomite, epsom salts, gem stones, gold, gypsum (1960–62), lime (1963), magnesite, olivine, silver, tungsten (1961), and values indicated by footnote 5			24,552		23,667		21,827		24,057
Total			72,404		66,448		68,474		71,430

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States, by States—Continued

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
WEST VIRGINIA								
Clays—thousand short tons	626	$2,639	475	$2,193	447	$2,086	414	$2,044
Coal (bituminous)—do	118,944	597,222	113,070	558,525	118,499	578,293	132,568	634,794
Gem stones	[4]	1	[4]	[5]	[4]	[5]	[4]	[5]
Natural gas—million cubic feet	208,757	54,694	210,556	57,692	210,698	57,942	210,223	55,919
Natural gas liquids:								
Natural gasoline—thousand gallons	23,211	1,513	34,095	2,296	32,921	2,216	[5]	[5]
LP gases—do	329,874	16,527	342,646	17,826	344,969	17,475	[5]	[5]
Petroleum (crude)—thousand 42-gallon barrels	2,300	9,361	2,760	11,426	3,470	13,880	[6] 3,243	[6] 12,940
Salt—thousand short tons	920	3,673	899	3,510	1,042	4,635	[5]	[5]
Sand and gravel—do	4,506	9,802	4,882	10,152	5,202	10,942	4,808	10,578
Stone [7]—do	8,001	14,001	7,628	13,244	7,506	13,242	9,452	14,489
Value of items that cannot be disclosed: Bromine, (1960), calcium-magnesium chloride, cement, lime, stone (dimension sandstone), and values indicated by footnote 5		13,195		13,385		14,753		37,051
Total		722,628		690,250		[8] 715,464		767,815
WISCONSIN								
Abrasive stones—short tons	[19] 397	[19] $12	[19] 560	[19] $17	[19] 569	[19] $17	[20] 561	[20] $21
Clays—thousand short tons	144	156	126	130	137	156	111	140
Iron ore (usable)—thousand long tons, gross weight	1,502	[5]	1,122	[5]	1,045	[5]	938	[5]
Lead (recoverable content of ores, etc.)—short tons	1,165	273	680	140	1,394	256	1,116	241
Peat—do	8,500	[5]	[5]	[5]	[5]	[5]	2,667	136
Sand and gravel—thousand short tons	35,681	25,648	39,978	28,457	33,649	24,408	35,633	26,348
Stone—do	16,486	22,302	13,418	19,686	13,392	19,709	13,583	18,744
Zinc (recoverable content of ores, etc.)—short tons	18,410	4,750	13,865	3,189	13,292	3,057	15,114	3,476
Value of items that cannot be disclosed: Abrasive stones (tube-mill liners, 1963), cement, gem stones, lime, and values indicated by footnote 5		25,619		21,892		20,686		19,220
Total		78,760		73,511		68,289		68,326

Beryllium concentrate	short tons, gross weight	5	$2	2	$1	1	(10)	(9)	(10)
Clays	thousand short tons	[3] 788	[3] 9,571	[3] 859	[3] 10,301	1,141	$11,138	1,113	$11,387
Coal (bituminous)	do	2,024	6,992	2,529	8,573	2,569	8,198	3,124	9,922
Copper (recoverable content of ores, etc.)	short tons			1	1				
Gem stones		(4)	68	(4)	83	(4)	85	(4)	110
Gold (recoverable content of ores, etc.)	troy ounces	40	1	1	(10)			4	(10)
Gypsum	thousand short tons	13	46	(5)	(5)	(5)	(5)	(5)	(5)
Iron ore (usable)	thousand long tons, gross weight	(5)	(5)	(5)	(5)	739	6,441	1,604	17,504
Natural gas	million cubic feet	181,610	21,793	194,674	24,334	204,996	29,929	209,060	29,687
Natural gas liquids:									
Natural gasoline	thousand gallons	72,195	4,535	76,349	4,705	78,780	4,935	86,014	5,523
LP gases	do	120,693	5,279	132,831	5,451	149,438	5,762	150,437	6,203
Petroleum (crude)	thousand 42-gallon barrels	133,910	336,114	141,937	354,843	135,847	338,259	[6] 144,407	[6] 361,018
Pumice	thousand short tons	33	30	20	20	42	41	(5)	(5)
Sand and gravel	do	5,928	5,356	6,669	5,356	7,769	8,104	7,901	7,874
Stone	do	1,401	2,302	2,594	3,315	1,755	3,054	1,940	2,991
Uranium ore	short tons	1,357,225	27,387	1,521,064	28,218	1,301,784	25,715	1,475,070	27,243
Vanadium (recoverable in ore and concentrate)	do	(5)	(5)	(5)	(5)	(5)	442	(5)	435
Value of items that cannot be disclosed: Cement, clays (fire clay 1960–61, miscellaneous clay 1960–61), lime (1961–63), sheet mica (1960–61), phosphate rock, silver (1960–61), sodium carbonates and sulfates, vermiculite (1961–63), and values indicated by footnote 5			19,780		21,046		20,467		24,736
Total			439,256		466,247		[8] 462,570		504,633

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes certain cement, included with "Value of items that cannot be disclosed."
[3] Excludes certain clays, included with "Value of items that cannot be disclosed."
[4] Weight not recorded.
[5] Figure withheld to avoid disclosing individual company confidential data.
[6] Preliminary figure.
[7] Excludes certain stone, included with "Value of items that cannot be disclosed."
[8] Revised figure.
[9] Less than 0.5 ton.
[10] Less than $500.
[11] Includes 805 tons of low-grade beryllium ore in 1961, 760 tons in 1962, and 750 tons in 1963.
[12] Less than 500 short tons.
[13] Excludes salt in brine, included with "Value of items that cannot be disclosed."
[14] Excludes quantity consumed by American Chrome Co.
[15] Recoverable zinc valued at the yearly average price of Prime Western slab zinc, East St. Louis market. Represents value established after transportation, smelting, and manufacturing charges have been added to the value of ore at mine.
[16] Less than 500 long tons.
[17] Less than 500 troy ounces.
[18] Less than 500 barrels.
[19] Grinding pebbles and tube-mill liners.
[20] Grinding pebbles; tube-mill liners included with "Value of items that cannot be disclosed."

TABLE 6.—Mineral production [1] in the Canal Zone and islands administered by the United States [2]

Area and mineral		1960		1961		1962		1963	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
American Samoa:									
Pumice	thousand short tons					50	$108		
Sand and gravel	do.					3	4	77	$193
Stone	do.	523	$261	362	$286	1,103	1,788	944	2,351
Total			261		286		1,900		2,544
Canal Zone:									
Sand and gravel	thousand short tons	65	68	75	73	70	77	84	87
Stone (crushed)	do.	203	306	163	271	207	359	162	281
Total			374		344		436		368
Canton: Stone (crushed)	thousand short tons					(3)	(4)	2	6
Guam:									
Sand and gravel	do.	1	1	38	49				
Stone	do.	962	2,194	292	591	82	123	307	439
Total			2,195		640		123		439
Johnston:									
Sand and gravel	thousand short tons	1	4	1	1				
Stone	do.	2	5	1	2				
Total			9		3				
Midway: Stone (crushed)	thousand short tons			11	34				
Virgin Islands: Stone (crushed)	do.	15	51	20	75	21	82	66	329
Wake: Stone (crushed)	do.	36	49	24	62	5	41	9	51

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Production data for Canton and Wake furnished by U.S. Department of Commerce, Civil Aeronautics Administration; Midway and Johnston, by U.S. Department of the Navy; Guam, by the Government of Guam; American Samoa, by the Government of American Samoa.
[3] Less than 500 short tons.
[4] Less than $500.

TABLE 7.—Mineral production [1] in the Commonwealth of Puerto Rico

Mineral	1960		1961		1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement—thousand 376-pound barrels	5,441	$14,546	5,931	$16,946	6,347	$20,018	7,217	$22,090
Clays—thousand short tons	160	102	184	112	219	131	200	158
Lime—do	1	15	1	15	1	14	4	103
Salt—do	[2]	[2]					8	131
Sand and gravel—do	8,996	8,669	11,370	10,385	7,378	9,793	7,616	10,407
Stone—do	4,219	7,661	5,049	7,284	5,589	8,551	5,334	8,237
Value of items that cannot be disclosed: Other nonmetals and values indicated by footnote 2		74						
Total		31,067		34,742		38,507		41,126

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers)
[2] Figure withheld to avoid disclosing individual company confidential data.

TABLE 8.—U.S. imports for consumption of principal minerals and products

Mineral	1962		1963	
	Quantity	Value	Quantity	Value
Metals:				
Aluminum:				
Metal, short tons	[1] 310,955	[1] $129,997	415,668	$163,524
Scrap, do	6,496	1,864	9,306	2,307
Plates, sheets, bars, etc, do	59,188	37,147	41,243	25,440
Antimony:				
Ore (antimony content), do	8,602	2,168	9,784	2,675
Needle or liquated, do	17	8	22	11
Metal, do	4,720	2,300	5,717	2,968
Oxide, do	2,910	1,391	2,089	1,038
Arsenic: White (As_2O_3 content), do	15,758	1,077	14,559	1,058
Bauxite: Crude, thousand long tons	[1] 10,575	[1] 121,888	9,170	114,077
Beryllium ore, short tons	8,552	2,897	6,243	1,672
Bismuth (general imports), pounds	816,190	1,478	1,123,466	2,082
Boron carbide, do	9,124	34	13,468	39
Cadmium:				
Metal, thousand pounds	1,117	1,640	991	2,064
Flue dust (cadmium content), do	1,570	850	1,069	795
Calcium:				
Metal, pounds	43,962	52	26,343	32
Chloride, short tons	1,896	60	2,234	67
Chromate:				
Ore and concentrate (Cr_2O_3 content), do	613,572	23,700	605,349	20,135
Ferrochrome (chromium content), do	[1] 24,914	[1] 9,845	19,945	6,807
Metal, do	648	993	860	1,308
Cobalt:				
Metal, thousand pounds	[1] 11,809	[1] 17,119	10,322	14,677
Oxide (gross weight), do	978	943	468	451
Salts and compounds (gross weight), do	120	47	94	45
Columbium ore, pounds	5,050,888	[1] 3,419	5,909,512	3,144
Copper: (copper content)				
Ore [2], short tons	116	202	11,498	6,567
Concentrates [2], do	2,206	1,212		
Regulus, black, coarse, do	22	12	2,800	1,674
Unrefined, black, blister, do	1,119	669	119,231	72,502
Refined in ingots, etc, do	[1] 130,197	[1] 76,995	123,149	71,342
Old and scrap, do	3,846	2,242	2,195	1,259
Old brass and clippings, do	1,289	738	945	558
Ferroalloys: Ferrosilicon (silicon content), do	2,573	976	2,376	744
Gold:				
Ore and base bullion, troy ounces	382,468	13,281	313,280	10,583
Bullion, do	3,929,718	137,652	967,339	33,831
Iron ore:				
Ore, thousand long tons	[1] 33,409	[1] 324,573	33,263	323,158
Pyrites cinder, long tons	4,248	26	3,511	48
Iron and steel:				
Pig iron, short tons	[1] 500,074	24,684	645,334	28,937
Iron and steel products (major):				
Iron products, do	54,132	10,634	64,408	13,347
Steel products, do	[1] 4,243,340	[1] 513,978	5,517,364	646,747
Scrap, do	189,035	5,726	195,383	5,701
Tinplate scrap, do	21,092	341	21,824	403
Lead:				
Ore, flue dust, matte (lead content), do	[1] 133,080	[1] 21,003	134,445	21,436
Base bullion (lead content), do	2,083	710	3,758	1,792
Pigs and bars (lead content), do	257,866	41,570	220,398	40,226
Reclaimed, scrap, etc., (lead content), do	2,078	269	15,405	2,009
Sheets, pipe, and shot, do	2,276	474	2,429	513
Babbitt metal and solder (lead content), do	1,030	3,443	1,246	3,207
Type metal and antimonial lead (lead content), short tons	7,512	1,393	3,196	621
Manufactures, do	2,021	978	2,295	792
Magnesium:				
Metallic and scrap, do	2,359	1,080	1,982	825
Alloys (magnesium content), do	53	106	374	603
Sheets, tubing, ribbons, wire and other forms (magnesium content), short tons	35	83	18	112
Manganese:				
Ore (35 percent or more manganese) (manganese content), short tons	[1] 940,154	[1] 66,089	1,124,109	67,406
Ferromanganese (manganese content), do	[1] 97,870	[1] 16,757	115,377	16,974
Mercury:				
Compounds, pounds	46,368	105	14,899	37
Metal, 76-pound flasks	[1] 31,552	[1] 5,090	42,872	6,766
Minor metals: Selenium and salts, pounds	160,389	866	191,210	788

See footnotes at end of table.

TABLE 8.—U.S. imports for consumption of principal minerals and products—Continued

Mineral	1962		1963	
	Quantity	Value	Quantity	Value
Metals—Continued				
Nickel:				
Ore and matte—short tons	14	5	34	3
Pigs, ingots, shot, cathodes—do	[1] 115,972	[1] 175,425	108,127	161,804
Scrap—do	601	545	703	520
Oxide—do	8,661	9,086	12,887	13,753
Platinum group:				
Unrefined materials:				
Grains and nuggets, including crude, dust, and residues—troy ounces	23,366	1,610	50,691	3,696
Sponge and scrap—do	6,185	684	7,647	560
Osmiridium—do	24	1		
Refined metal:				
Platinum—do	210,220	16,097	701,213	27,491
Palladium—do	431,872	9,370	503,843	11,052
Iridium—do	9,001	578	13,059	959
Osmium—do	1,062	55	2,091	50
Rhodium—do	30,123	3,965	36,500	4,801
Ruthenium—do	8,499	339	3,917	166
Radium:				
Radium salts—milligrams	46,962	700	44,660	304
Radioactive substitutes	[2]	1,732	[2]	1,081
Rare earths: Ferrocerium and other cerium alloys—pounds	20,608	60	16,430	49
Silver:				
Ore and base bullion—thousand troy ounces	37,168	35,814	41,660	47,708
Bullion—do	39,191	36,907	17,402	19,573
Tantalum: Ore—pounds	1,211,757	3,527	944,459	2,411
Tin:				
Ore (tin content)—long tons	5,364	13,595	[4]	3,077
Blocks, pigs, grains, etc—do	[1] 41,401	[1] 103,103	43,601	106,700
Dross, skimmings, scrap, residues, and tin alloys, n.s.p.f—long tons	[1] 2,185	[1] 913	2,816	2,067
Tinfoil, powder, flitters, etc	[3]	819	[3]	731
Titanium:				
Ilmenite—short tons	166,434	4,470	200,880	5,088
Rutile—do	35,966	2,646	71,990	4,921
Metals—pounds	1,849,034	1,733	2,957,292	2,565
Ferrotitanium—do	240,326	88	82,113	35
Compounds and mixtures—do	[1]33,152,354	[1] 6,311	51,093,307	9,468
Tungsten: (Tungsten content)				
Ore and concentrate—thousand pounds	[1] 4,030	[1] 2,922	3,060	1,579
Metal—pounds	497,054	938	147,811	274
Ferrotungsten—thousand pounds	534	531	882	609
Other alloys—pounds	41,807	47	41,556	40
Zinc:				
Ore (zinc content)—short tons	387,321	31,817	371,919	30,757
Blocks, pigs, and slabs—do	135,995	28,478	132,332	27,942
Sheets—do	[1] 1,303	[1]365	1,532	413
Old, dross, and skimmings—do	2,768	406	2,876	446
Dust—do	909	207	2,608	589
Manufactures	[3]	1,139	[3]	979
Zirconium: Ore, including zirconium sand—short tons	30,872	845	52,543	1,716
Nonmetals:				
Abrasives: Diamonds (industrial)—carats	12,281,143	51,040	11,847,028	49,871
Asbestos—short tons	[1] 675,953	[1] 64,112	667,860	61,739
Barite:				
Crude and ground—do	736,867	6,012	578,394	4,643
Witherite (crude)—do	1,431	59	2,690	114
Chemicals—do	5,319	595	4,646	543
Bromine—pounds	461,108	245	374,012	168
Cement—376-pound barrels	[1] 5,632,699	[1] 12,855	4,030,046	10,202
Clays:				
Raw—short tons	129,631	2,475	123,456	2,344
Manufactured—do	2,598	66	2,029	61
Cryolite—do	12,472	933	26,915	1,808
Feldspar: Crude—long tons	33	1	68	2
Fluorspar—short tons	595,695	15,596	555,123	14,104
Gem stones:				
Diamonds—carats	[1] 2,403,421	[1] 191,736	2,767,261	223,847
Emeralds—do	196,649	2,798	190,933	2,081
Other	[3]	[1] 30,068	[3]	29,864
Graphite—short tons	39,528	1,783	52,184	2,000
Gypsum:				
Crude, ground, calcined—do	5,422,656	10,545	5,490,524	10,949
Manufactures	[3]	1,367	[3]	1,408
Iodine, crude—thousand pounds	3,026	2,841	3,336	2,958

See footnotes at end of table.

TABLE 8.—U.S. imports for consumption of principal minerals and products—Continued

Mineral		1962		1963	
		Quantity	Value	Quantity	Value
Nonmetals—Continued					
Kyanite	short tons	5,281	234	2,624	119
Lime:					
Hydrated	do	1,141	19	692	12
Other	do	71,970	939	90,676	1,005
Dead-burned dolomite	do	4,456	245	9,389	455
Magnesium:					
Magnesite	do	107,169	5,939	96,562	5,093
Compounds	do	14,860	589	13,552	496
Mica:					
Uncut sheet and punch	pounds	[1] 1,110,739	[1] 1,796	1,133,521	1,615
Scrap	short tons	4,458	55	8,150	132
Manufactures	do	5,403	7,922	4,353	5,950
Mineral-earth pigments: Iron oxide pigments:					
Natural	do	2,937	128	2,877	137
Synthetic	do	6,206	960	7,215	1,150
Ocher, crude and refined	do	146	9	144	8
Siennas, crude and refined	do	879	84	610	62
Umber, crude and refined	do	2,663	94	2,641	95
Vandyke brown	do	256	21	217	18
Nitrogen compounds (major), including urea	do	[1] 1,559,137	[1] 69,212	1,195,330	46,807
Phosphate, crude	long tons	133,628	3,551	160,708	3,651
Phosphatic fertilizers	do	83,894	4,630	94,331	5,044
Pigments and salts:					
Lead pigments and salts	short tons	18,986	3,027	26,295	4,400
Zinc pigments and salts	do	15,282	2,729	16,360	2,911
Potash	do	[1] 616,684	[1] 21,764	1,041,376	31,137
Pumice:					
Crude or unmanufactured	do	7,136	70	7,576	84
Wholly or partly manufactured	do	3,184	89	3,555	119
Manufactures, n.s.p.f.		([3])	22	([3])	47
Quartz crystal (Brazillian pebble)	pounds	935,927	843	712,897	547
Salt	short tons	1,374,219	5,097	1,371,443	5,074
Sand and gravel:					
Glass sand	do	31,416	64	22,724	69
Other sand [2]	do	307,637	415	336,547	430
Gravel [2]	do	29,198	32		
Sodium sulfate	thousand short tons	188	3,768	159	3,081
Stone and whiting		([3])	17,204	([3])	18,978
Strontium: Mineral	short tons	7,489	189	16,232	372
Sulfur and pyrites:					
Sulfur:					
Ores [2]	long tons	[1] 442,943	[1] 8,433	1,351,216	23,942
Other forms, n.e.s. [2]	do	[1] 597,530	[1] 11,877		
Pyrites	do	301,899	747	194,171	488
Talc: Unmanufactured	short tons	25,777	1,069	25,681	1,088
Fuels:					
Carbon black:					
Acetylene	pounds	7,883,462	1,384	6,233,224	1,104
Gas black and carbon black	do	284,296	49	1,261,215	216
Coal:					
Anthracite	short tons	7,583	63	[2] 4,625	44
Bituminous, slack, culm, and lignite	do	232,424	1,858	172,224	1,335
Briquets	do	8,396	410	4,620	82
Coke	do	141,883	1,855	152,595	2,047
Peat:					
Fertilizer grade	do	261,347	12,448	255,709	12,040
Poultry and stable grade	do	6,331	420	5,622	318
Petroleum:					
Crude [5]	thousand barrels	450,157	1,011,914	454,620	1,024,973
Gasoline [6]	do	[1] 34,166	[1] 104,404	49,093	135,487
Kerosine	do	3	8	223	774
Fuel oil	do	271,159	575,463	277,953	575,935
Unfinished oils	do	21,527	57,224	15,936	33,919
Asphalt	do	6,698	15,845	6,175	15,161
Miscellaneous	do	30	421	30	462

[1] Revised figure.
[2] Effective Sept. 1, 1963—data no longer separately classified.
[3] Weight not recorded.
[4] January–August data reported as tin content, 793 long tons; September–December reported in gross weight, 2,140 long tons.
[5] Includes some quantities imported free for supplies of vessels and aircraft.
[6] Includes jet fuel, liquefied gases and naphtha, but excludes benzol (1962: 547,537 barrels, $4,927,771); 1963: 323,108 barrels ($3,719,309).

Source: Bureau of the Census.

TABLE 9.—U.S. exports of principal minerals and products

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals:				
Aluminum:				
Ingots, slabs, crude—short tons	[1] 151,197	[1] $66,596	165,340	$71,875
Scrap—do	65,534	20,183	71,040	21,369
Plates, sheets, bars, etc—do	[1] 40,128	[1] 32,970	53,363	39,276
Castings and forgings—do	[1] 1,541	5,522	1,431	4,017
Antimony: Metals and alloys, crude—do	35	15	14	12
Arsenic: Calcium arsenate—pounds	942,399	104	186,577	18
Bauxite, including bauxite concentrates—long tons	258,561	19,874	203,196	15,696
Aluminum sulfate—short tons	17,776	608	17,576	559
Other aluminum compounds—do	87,671	10,936	228,076	20,635
Beryllium—pounds	63,975	352	100,323	457
Bismuth: Metals and alloys—do	118,056	176	32,293	42
Cadmium—thousand pounds	717	1,139	1,313	3,070
Calcium chloride—short tons	43,830	1,687	36,984	1,527
Chrome:				
Ore and concentrate:				
Exports—do	2,686	108	9,726	352
Reexports—do	51,254	2,033	71,324	2,827
Chromic acid—do	834	487	936	553
Ferrochrome—do	3,075	1,182	2,354	773
Cobalt—pounds	1,936,487	997	2,405,777	2,403
Columbium metals, alloys, and other forms—do	38,157	277	61,163	531
Copper:				
Ore, concentrate, composition metal, and unrefined copper (copper content)—short tons	1,916	1,045	1,210	638
Refined copper and semimanufactures—do	356,535	234,605	344,960	225,649
Other copper manufactures—do	6,768	5,107	5,811	4,273
Copper sulfate or blue vitriol—do	1,916	456	851	228
Copper base alloys—do	46,030	36,024	44,494	34,587
Ferroalloys:				
Ferrosilicon—pounds	8,202,626	1,349	6,260,880	948
Ferrophosphorus—do	28,260,782	595	82,722,701	1,302
Gold:				
Ore and base bullion—troy ounces	22,724	809	30,107	1,140
Bullion, refined—do	10,861,510	380,153	5,789,826	202,644
Iron ore—thousand long tons	5,898	[1] 62,847	6,813	76,390
Iron and steel:				
Pig iron—short tons	154,380	8,283	70,154	4,479
Iron and steel products (major):				
Semimanufactures—do	[1] 1,506,071	[1] 282,563	1,609,332	301,003
Manufactured steel mill products—do	[1] 759,527	[1] 261,047	1,054,374	309,554
Advanced products—do	(2)	[1] 174,674	(2)	165,283
Iron and steel scrap: Ferrous scrap, including rerolling materials—short tons	[1] 5,112,266	[1] 149,037	6,363,617	174,611
Lead:				
Ore, matte, base bullion (lead content)—do	2,898	235	4	(2)
Pigs, bars, anodes—do	2,108	528	1,088	313
Scrap—do	2,461	457	2,421	1,034
Magnesium:				
Metal and alloys and semimanufactured forms, n.e.c—short tons	7,020	4,659	3,958	3,018
Powder—do	21	53	33	87
Manganese:				
Ore and concentrates—do	8,643	1,012	8,296	926
Ferromanganese—do	4,114	629	678	155
Mercury:				
Exports—76-pound flasks	224	64	187	46
Reexports—do	257	43	----------	----------
Molybdenum:				
Ore and concentrate (molybdenum content)—pounds	15,554,662	22,901	26,545,066	39,360
Metals and alloys, crude and scrap—do	75,211	70	139,202	179
Wire—do	12,088	374	30,892	631
Semifabricated forms, n.e.c—do	8,961	135	9,109	110
Powder—do	25,219	84	16,741	58
Ferromolybdenum—do	189,823	305	239,034	379
Nickel:				
Ore—short tons	45	16	12	5
Alloys and scrap (including monel metal), ingots, bars, sheets, etc—short tons	25,510	20,796	59,107	27,279
Catalysts—do	1,093	1,963	905	1,749
Nickel-chrome electric resistance wire—do	190	965	189	953
Semifabricated forms, n.e.c—do	803	3,463	714	3,199

See footnotes at end of table.

TABLE 9.—U.S. exports of principal minerals and products—Continued

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals—Continued				
Platinum:				
Ore, concentrate, metal and alloys in ingots, bars, sheets, anodes, and other forms, including scrap—troy ounces	49,651	1,514	51,236	3,650
Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium (metal and alloys including scrap—troy ounces	10,940	459	11,776	507
Platinum group manufactures, except jewelry	(2)	4,106	(2)	2,256
Radium metal (radium content)—milligrams	328	4	311	7
Rare earths:				
Cerium ore, metal, and alloys—pounds	3,708	16	128,612	41
Lighter flints—do	38,501	173	40,100	182
Silver:				
Ore and base bullion—thousand troy ounces	770	789	1,298	1,650
Bullion, refined—do	12,287	12,586	30,187	38,372
Tantalum:				
Ore, metal, and other forms—pounds	54,256	716	100,400	861
Powder—do	7,445	353	14,146	425
Tin:				
Ingots, pigs, bars, etc.:				
Exports—long tons	335	840	1,544	4,225
Reexports—do	100	267	81	207
Tin scrap and other tin bearing material except tinplate scrap—long tons	5,587	211	5,862	2,423
Tin cans finished or unfinished—do	25,531	13,927	21,595	12,169
Titanium:				
Ore and concentrate—short tons	1,224	167	1,212	176
Sponge (including iodide titanium) and scrap—do	818	925	1,261	1,232
Intermediate mill shapes—do	453	2,609	417	2,322
Mill products, n.e.c—do	108	1,493	77	1,122
Ferrotitanium—do	130	95	211	183
Dioxide and pigments—do	29,095	8,636	26,702	8,051
Tungsten: Ore and concentrate:				
Exports—do	40	80	50	66
Reexports—do	159	132	----------	----------
Vanadium ore and concentrate, pentoxide, etc. (vanadium content)—pounds	[1] 2,042,946	[1]2,998	1,071,817	1,641
Zinc:				
Ore and concentrate (zinc content)—short tons	136	46	17	6
Slabs, pigs, or blocks—do	36,102	8,050	33,853	7,506
Sheets, plates, strips, or other forms, n.e.c—do	3,547	2,391	3,756	2,742
Scrap (zinc content)—do	7,940	956	1,794	539
Dust—do	676	240	759	261
Semifabricated forms, n.e.c—do	1,613	1,254	1,532	1,163
Zirconium:				
Ore and concentrate—do	1,666	365	1,418	305
Metals and alloys and other forms—pounds	[1] 221,275	1,740	291,792	2,500
Nonmetals:				
Abrasives:				
Grindstones—short tons	127	53	41	34
Diamond dust and powder—carats	828,611	2,225	1,095,737	2,983
Diamond grinding wheels—do	310,330	1,990	373,053	2,354
Other natural and artificial metallic abrasives and products	(2)	28,489	(2)	30,403
Asbestos: Unmanufactured:				
Exports—short tons	2,824	578	9,978	1,289
Reexports—do	125	20	66	15
Boron: Boric acid, borates, crude and refined—pounds	584,528,807	24,736	677,823,693	27,519
Bromine, bromides, and bromates—do	8,800,351	2,228	10,839,960	2,353
Cement—376-pound barrels	380,383	1,853	460,088	2,072
Clays:				
Kaolin or china clay—short tons	118,890	2,939	111,717	3,314
Fire clay—do	188,282	3,462	264,440	5,184
Other clays—do	309,776	10,454	363,191	12,875
Cryolite—do	1,109	196	3,719	689
Fluorspar—do	1,308	119	1,202	157
Graphite:				
Amorphous—do	746	110	533	89
Crystalline flake, lump or chip—do	127	42	144	49
Natural, n.e.c—do	286	71	222	51

See footnotes at end of table.

TABLE 9.—U.S. exports of principal minerals and products—Continued

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Nonmetals—Continued				
Gypsum:				
Crude, crushed or calcined—thousand short tons	20	736	17	669
Manufactures, n.e.c	(2)	566	(2)	762
Iodine, iodide, iodates—thousand pounds	178	296	141	327
Kyanite and allied minerals—short tons	3,568	287	5,050	442
Lime—do	19,512	660	17,463	565
Mica:				
Unmanufactured—pounds	430,856	166	594,427	148
Manufactured:				
Ground or pulverized—do	7,427,420	432	7,244,428	413
Other—do	197,441	765	204,246	831
Mineral-earth pigments: Iron oxide, natural and manufactured—short tons	3,754	1,076	4,189	1,306
Nitrogen compounds (major)—do	[1] 906,924	[1] 43,538	824,295	41,357
Phosphate rock—long tons	[1] 4,242,057	[1] 38,886	4,612,299	40,726
Phosphatic fertilizers (superphosphates)—do	[1] 557,284	[1] 27,636	601,887	29,220
Pigments and salts (lead and zinc):				
Lead pigments—short tons	1,919	595	1,845	620
Zinc pigments—do	2,411	658	3,801	963
Lead salts—do	711	249	401	135
Potash:				
Fertilizer—do	[1] 845,744	[1] 28,296	707,039	22,202
Chemical—do	13,171	2,435	14,703	3,317
Quartz crystal (raw)	(2)	448	(2)	525
Radioactive isotopes, etc—curie	[1] 226,775	1,895	146,783	2,548
Salt:				
Crude and refined—short tons	[1] 670,532	[1] 3,638	781,135	4,140
Shipments to noncontiguous territories—do	11,347	823	10,021	881
Sodium and sodium compounds:				
Sodium sulfate—do	50,914	1,486	45,163	1,379
Sodium carbonate—thousand short tons	152	4,693	184	5,722
Stone:				
Limestone, crushed, ground, broken—short tons	621,177	1,547	762,658	1,753
Marble and other building and monumental—cubic feet	534,919	1,795	452,167	1,669
Stone, crushed, ground, broken—short tons	114,744	2,166	110,949	2,095
Manufactures of stone	(2)	501	(2)	585
Sulfur:				
Crude—long tons	1,537,419	35,496	1,603,438	33,531
Crushed, ground, flowers of—do	16,567	1,799	9,199	1,057
Talc:				
Crude and ground—short tons	46,939	2,133	56,483	2,690
Manufactures, n.e.c—do	122	97	107	88
Powders—talcum (face and compact)	(2)	1,286	(2)	1,140
Fuels:				
Carbon black—thousand pounds	442,437	[1] 41,036	370,928	35,447
Coal:				
Anthracite—short tons	[1] 1,801,724	[1] 24,675	3,353,192	43,669
Bituminous—do	[1] 38,413,371	351,319	47,078,435	429,864
Briquets—do	18,596	233	12,380	207
Coke—do	364,032	7,122	451,241	8,318
Petroleum:				
Crude—thousand barrels	[1] 1,790	[1] 5,086	1,697	4,616
Gasoline—do	5,987	41,339	6,418	44,720
Kerosine—do	312	1,817	513	3,405
Distillate oil—do	8,918	30,071	16,808	55,550
Residual oil—do	12,852	[1] 32,232	15,281	36,411
Lubricating oil—do	[1] 17,169	[1] 225,499	17,822	229,443
Asphalt—do	717	4,572	656	3,847
Liquefied petroleum gases—do	3,875	11,250	4,597	13,438
Wax—do	1,430	28,484	1,455	29,094
Coke—do	7,456	29,357	10,763	38,170
Petrolatum—do	238	6,151	240	6,202
Miscellaneous—do	476	15,423	566	15,496

[1] Revised figure.
[2] Weight not recorded.
[3] Less than $1,000.
[4] Includes naphtha, but excludes benzol: 1962—982,361 barrels ($12,027,669); 1963—1,541,316 barrels ($16,759,104).

Source: Bureau of the Census.

TABLE 10.—Comparison of world and U.S. production of principal metals and minerals

Mineral	1962			1963		
	World	United States		World	United States	
	Thousand short tons (unless otherwise stated)		Percent of world	Thousand short tons (unless otherwise stated)		Percent of world
Fuels:						
Coal:						
Bituminous	1,856,097	419,094	23	1,927,986	456,223	24
Lignite	755,318	3,055	(1)	796,046	2,705	(1)
Pennsylvania anthracite	198,100	16,894	9	202,000	18,267	9
Coke (excluding breeze):						
Gashouse [2]	50,380	164	(1)	50,120	160	(1)
Oven and beehive	301,020	51,910	17	313,236	54,278	17
Fuel briquets and packaged fuel	130,500	588	(1)	134,000	565	(1)
Natural gas (marketable)—million cubic feet	(3)	13,867,622	(3)	(3)	14,746,633	(3)
Peat	169,500	4 572	(1)	169,500	4 579	(1)
Petroleum (crude)—thousand barrels	8,882,218	2,676,189	30	9,535,434	2,752,723	29
Nonmetals:						
Asbestos	3,055	53	2	3,200	67	2
Barite	3,440	887	26	3,200	803	25
Cement [5]—thousand barrels	2,098,128	351,932	17	2,201,159	368,406	17
China clay	(3)	2,998	(3)	(3)	3,164	(3)
Corundum	9			11		
Diamonds—thousand carats	34,006			36,661		
Diatomite	1,630	482	30	1,610	482	30
Feldspar—thousand long tons	1,540	492	32	1,590	549	35
Fluorspar	2,410	206	9	2,340	200	9
Graphite	590	(6)	(6)	730	(6)	(6)
Gypsum	51,690	9,969	19	54,000	10,388	19
Lime (sold or used by producers)	(3)	13,753	(3)	(3)	14,521	(3)
Magnesite	8,600	492	6	9,050	528	6
Mica (including scrap)—thousand pounds	390,000	215,767	55	400,000	218,749	55
Nitrogen, agricultural [5 7]	12,900	3,353	26	13,800	3,778	27
Phosphate rock—thousand long tons	47,450	19,382	41	50,400	19,835	39
Potash (K_2O equivalent)	10,800	2,453	23	12,000	2,866	24
Pumice [8]	13,500	2,321	17	14,710	2,618	18
Pyrites—thousand long tons	19,800	916	5	19,700	825	4
Salt [5]	100,700	28,807	29	104,900	30,652	29
Strontium [8]	9			17		
Sulfur, elemental—thousand long tons	12,100	5,925	49	12,560	5,829	46
Talc, pyrophyllite, and soapstone	2,990	772	26	3,150	804	26
Vermiculite [8]	295	206	70	329	226	69
Metals, mine basis:						
Antimony (content of ore and concentrate)—short tons	58,700	631	1	61,100	645	1
Arsenic, white [8]	54	(6)	(6)	53	(6)	(6)
Bauxite—thousand long tons	30,535	1,369	4	29,835	1,525	5
Beryllium concentrate—short tons	10,900	978	9	7,400	751	10
Bismuth—thousand pounds	6,700	(6)	(6)	6,500	(6)	(6)
Cadmium—do	27,100	11,137	41	26,400	9,990	38
Chromite	4,840			4,475		
Cobalt (contained) [8]—short tons	15,900	(6)	(6)	12,700	(6)	(6)
Columbium-tantalum concentrate [8] thousand pounds	9,210			10,660		
Copper (content of ore and concentrate)	5,090	1,228	24	5,220	1,213	23
Gold—thousand troy ounces	49,800	1,556	3	51,700	1,469	3
Iron ore—thousand long tons	498,703	71,829	14	509,021	73,599	14
Lead (content of ore and concentrate)	2,760	237	9	2,800	253	9
Manganese ore (35 percent or more Mn)	15,782	25	(1)	16,090	11	(1)
Mercury—thousand 76-pound flasks	245	26	11	236	19	8
Molybdenum (content of ore and concentrate)—thousand pounds	75,100	51,244	68	91,600	65,011	71
Nickel (content of ore and concentrate)	401	11	3	384	11	3
Platinum groups (Pt, Pd, etc.) thousand troy ounces	1,630	29	2	1,530	50	3
Silver—do	241,800	36,345	15	249,500	35,000	14
Tin (content of ore and concentrate) long tons	187,000	(6)	(6)	191,000	(6)	(6)
Titanium concentrates:						
Ilmenite [8]	2,168	808	37	2,222	888	40
Rutile [8]	150	10	7	220	12	5
Tungsten concentrate (60 percent WO_3) short tons	73,300	8,429	11	64,700	5,657	9
Vanadium (content of ore and concentrate) [8]—short tons	8,286	5,233	63	7,004	3,862	55
Zinc (content of ore and concentrate)	3,890	505	13	3,970	529	13

See footnotes at end of table.

TABLE 10.—Comparison of world and U.S. production of principal metals and minerals—Continued

Mineral	1962			1963		
	World	United States		World	United States	
	Thousand short tons (unless otherwise stated)		Percent of world	Thousand short tons (unless otherwise stated)		Percent of world
Metals, smelter basis:						
Aluminum	5,595	2,118	38	6,095	2,313	38
Copper	5,360	1,323	25	5,500	1,297	24
Iron, pig (including ferroalloys)	291,820	67,636	23	308,970	73,853	24
Lead	2,655	376	14	2,795	395	14
Magnesium—short tons	145,900	68,955	47	154,800	75,845	49
Selenium [3]—thousand pounds	2,131	999	47	2,110	928	44
Steel ingots and castings	396,260	98,328	25	425,310	109,261	26
Tellurium [3]—thousand pounds	396	264	67	316	201	64
Tin—thousand long tons	190	[9] 5	3	192	[9] 2	1
Uranium oxide (U_3O_8) [3]—short tons	34,600	17,010	49	30,200	14,218	47
Zinc	3,750	879	23	3,830	893	23

[1] Less than 1 percent.
[2] Includes low- and medium-temperature and gashouse coke.
[3] Data not available.
[4] Agricultural use only.
[5] Including Puerto Rico.
[6] Bureau of Mines not at liberty to publish U.S. figure separately
[7] Year ended June 30 of year stated (United Nations).
[8] World total exclusive of U.S.S.R.
[9] U.S. imports of tin concentrates (tin content).

Employment and Injuries in the Mineral Industries

By Forrest T. Moyer[1]

OVERALL data for 1963 on injury experience and the levels of employment, worktime, and operating activity of the mineral industries are shown in the statistical tables of this chapter. The general groupings of the industries are presented in greater detail in Volumes I and II of the Minerals Yearbook. A corresponding chapter in Volume I contains additional breakdowns of the data on metal, nonmetal, sand and gravel, slag, and stone mines and quarries together with separate information on the related processing mills and plants including primary nonferrous smelters. The more specific information on the anthracite and bituminous-coal, petroleum and natural gas, peat, and natural asphalt industries is given in the similar chapter of Volume II.

Injury and employment data were collected from coal producers on the mandatory basis required by the Federal Coal Mine Safety Act (30 U.S.C., sec. 455). Producers of all other minerals (fuel and nonfuel) voluntarily reported the requested injury and employment data. The figures for 1963 are preliminary except for anthracite, coke, petroleum and natural gas, native asphalt, and slag which are final. Data for earlier years are final. The figures represent full coverage for all industries except the oil and gas industries for which coverage is not complete, particularly with respect to small companies.

The data in this chapter cover all production, development, maintenance, repair, technical, supervisory, and force-account construction personnel at mines, pits, quarries, wells, and brine operations, and associated mills, preparation, refining, or processing plants. Data on personnel in offices, sales, stores, or other affiliated activities not directly related to the extractive or processing operations, are excluded for all mineral industries except for the petroleum, natural gas, and slag industries in which such personnel are included.

[1] Chief, Branch of Accident Analysis, Division of Accident Prevention and Health.

TABLE 1.—Salient statistics of injury experience and employment data in the mineral industries of the United States, by industry groups

	1959	1960	1961	1962	1963 [1]
Average number of men working daily: [2]					
Coal mines	203,597	189,679	167,568	161,286	157,298
Coke plants	16,645	16,463	13,534	13,080	13,043
Petroleum and natural gas [3]	559,244	511,107	452,721	469,256	461,021
Peat	467	576	765	683	674
Asphalt and related bitumens (nat.) [4]		445	383	358	417
Metal mines	58,557	60,595	54,251	52,287	48,100
Nonmetal mines (except stone quarries)	18,765	18,653	18,281	16,917	15,600
Sand and gravel operations	59,492	52,352	55,726	53,599	52,800
Stone quarries	91,523	95,304	91,371	92,241	91,500
Slag (iron blast-furnace)	1,789	1,680	1,682	1,462	1,421
Metallurgical plants	55,655	58,689	56,065	54,807	51,100
Nonmetal mills	40,800	39,568	39,031	34,900	34,000
Total	1,106,534	1,045,111	951,378	950,876	926,974
Average number of active mine days:					
Coal mines	186	189	194	197	208
Coke plants	328	350	354	359	352
Petroleum and natural gas [3]	(5)	(5)	(5)	(5)	(5)
Peat	178	169	156	169	163
Asphalt and related bitumens (nat.) [4]		264	256	279	260
Metal mines	214	246	247	247	252
Nonmetal mines (except stone quarries)	239	242	238	235	257
Sand and gravel operations	(5)	(5)	217	218	216
Stone quarries	(5)	(5)	257	254	254
Slag (iron blast-furnace)	254	(5)	246	248	252
Metallurgical plants	289	309	315	319	327
Nonmetal mills	274	270	268	261	279
Total					
Man-days worked, in thousands:					
Coal mines	37,773	35,778	32,551	31,716	32,675
Coke plants	5,467	5,768	4,791	4,691	4,596
Petroleum and natural gas [3]	(5)	(5)	(5)	(5)	(5)
Peat	83	97	120	116	110
Asphalt and related bitumens (nat.) [4]		117	98	100	108
Metal mines	12,503	14,910	13,416	12,924	12,135
Nonmetal mines (except stone quarries)	4,488	4,515	4,347	3,979	4,009
Sand and gravel operations	(5)	(5)	12,117	11,690	11,403
Stone quarries	(5)	(5)	23,524	23,393	23,275
Slag (iron blast-furnace)	455	(5)	415	362	358
Metallurgical plants	16,095	18,149	17,669	17,501	16,718
Nonmetal mills	11,195	10,679	10,471	9,112	9,498
Total [6]	88,060	90,013	119,517	115,584	114,885
Man-hours worked, in thousands:					
Coal mines	296,031	281,528	255,296	248,946	256,518
Coke plants	43,626	46,066	38,306	37,502	36,759
Petroleum and natural gas [3]	1,185,146	1,063,332	951,743	984,172	974,877
Peat	738	866	1,038	977	957
Asphalt and related bitumens (nat.) [4]		948	792	800	873
Metal mines	100,576	119,653	107,678	103,867	97,420
Nonmetal mines (except stone quarries)	36,334	36,805	35,517	32,484	32,700
Sand and gravel operations	109,830	95,749	101,707	97,589	95,770
Stone quarries	199,321	202,366	192,705	193,453	192,640
Slag (iron blast-furnace)	3,681	3,613	3,361	2,927	2,867
Metallurgical plants	128,913	145,210	141,415	140,138	133,940
Nonmetal mills	90,706	86,386	83,925	74,621	77,200
Total [6]	2,194,902	2,082,521	1,913,481	1,917,475	1,902,521
Number of injuries:					
Fatal:					
Coal mines	293	325	294	289	284
Coke plants	3	3	3	11	7
Petroleum and natural gas [3] [7]	120	82	111	121	93
Peat	1				
Asphalt and related bitumens (nat.) [4]		1	1		2
Metal mines	73	84	50	61	41

See footnotes at end of table.

TABLE 1.—Salient statistics of injury experience and employment data in the mineral industries of the United States, by industry groups—Continued

	1959	1960	1961	1962	1963 [1]
Number of injuries—Continued					
Fatal—Continued					
Nonmetal mines (except stone quarries)	11	19	15	14	31
Sand and gravel operations	21	25	21	51	33
Stone quarries	52	39	32	67	60
Slag (iron-blast-furnace)	1				1
Metallurgical plants	11	12	9	24	12
Nonmetal mills	11	13	6	9	1
Total	597	603	542	647	565
Nonfatal:					
Coal mines	12,163	11,902	11,197	10,944	11,090
Coke plants	222	223	193	252	213
Petroleum and natural gas [3] [7]	10,543	9,110	8,697	9,336	9,125
Peat	14	24	17	19	11
Asphalt and related bitumens (nat.) [4]		38	30	13	35
Metal mines	3,281	3,794	3,669	3,263	3,110
Nonmetal mines (except stone quarries)	1,072	1,056	861	944	865
Sand and gravel operations	2,161	1,919	1,814	2,093	1,835
Stone quarries	4,790	4,668	4,280	3,299	3,560
Slag (iron blast-furnace)	43	34	30	29	35
Metallurgical plants	1,305	1,482	1,705	1,492	1,335
Nonmetal mills	2,156	1,794	1,680	1,383	1,475
Total	37,750	36,044	34,173	33,067	32,689
Injury rates per million man-hours:					
Fatal:					
Coal mines	0.99	1.15	1.15	1.16	1.11
Coke plants	.07	.07	.08	.29	.19
Petroleum and natural gas [3] [7]	.10	.08	.12	.12	.10
Peat	1.36				
Asphalt and related bitumens (nat.) [4]		1.06	1.26		2.29
Metal mines	.73	.70	.46	.59	.42
Nonmetal mines (except stone quarries)	.30	.52	.42	.43	.95
Sand and gravel operations	.19	.26	.21	.52	.34
Stone quarries	.26	.19	.17	.35	.31
Slag (iron blast-furnace)	.27				.35
Metallurgical plants	.09	.08	.06	.17	.09
Nonmetal mills	.12	.15	.07	.12	.01
Total	.27	.29	.28	.34	.30
Nonfatal:					
Coal mines	41.09	42.28	43.86	43.96	43.23
Coke plants	5.09	4.84	5.04	6.72	5.79
Petroleum and natural gas [3] [7]	8.90	8.57	9.14	9.49	9.36
Peat	18.97	27.72	16.38	19.45	11.49
Asphalt and related bitumens (nat.) [4]		40.10	37.90	16.25	40.09
Metal mines	32.62	31.71	34.07	31.42	31.92
Nonmetal mines (except stone quarries)	29.50	28.69	24.24	29.06	26.45
Sand and gravel operations	19.68	20.04	17.84	21.45	19.16
Stone quarries	24.03	23.07	22.21	17.05	18.48
Slag (iron blast-furnace)	11.68	9.41	8.93	9.91	12.21
Metallurgical plants	10.12	10.21	12.06	10.65	9.97
Nonmetal mills	23.77	20.77	20.02	18.53	19.11
Total	17.20	17.31	17.86	17.25	17.18

[1] Preliminary figures, except anthracite, coke, petroleum and natural gas, peat, native asphalt, and slag.
[2] Men at work each day mine was active.
[3] Includes officeworkers, as separate data not available.
[4] Asphalt and related bitumens (natural) canvass shown separately and included with fuels beginning 1960, formerly included with nonmetals.
[5] Data not available.
[6] Data may not add to totals shown because of rounding.
[7] Permanent total injuries are combined with fatalities, prior to 1963.

Injury experience.—The aggregate injury experience of the mineral industries in 1963 was essentially the same as in 1962. The combined (fatal and nonfatal) injury frequency rate of 17.48 per million man-hours was reduced only slightly from the comparable rate of 17.59 in 1962.

The number of fatal injuries, 565 in 1963, was 82 less than in the preceding year. As a result the fatal injury frequency rate of 0.30 represented a 12-percent improvement over 1962. The total number of 32,689 nonfatal injuries also was lower than in 1962. However, the frequency rate of 17.18 per million man-hours in 1963 was reduced only slightly from the corresponding figure of 17.25 for 1962.

Two major disasters (defined as a single accident in which five or more men are killed) occurred in bituminous coal mines in 1963. Both resulted from explosions of mine gases. One at Helper, Carbon County, Utah, killed 9 men; one at Dola, Harrison County, West Virginia, caused the death of 22 men. One major disaster in a potash mine 20 miles southwest of Moab in Grand County, Utah, killed 18 men. This disaster also resulted from an explosion of mine gas.

Employment and Worktime.—The average number of men working at all mineral extractive and processing operations declined 3 percent from 1962 to a total of 926,974. The decline in employment was noted in all major segments of the mineral industries groupings shown in the adjoining table. The average man worked 2,052 hours in 1963 compared with 2,017 hours during 1962.

The aggregate worktime in the mineral industries also decreased in 1963 to a total of 1,903 million man-hours or 1 percent below 1962. The decline was general for all major segments except for the coal industry. Worktime in coal mining and cleaning in 1963 was 3 percent above 1962.

Work Stoppages.—The U.S. Department of Labor, Bureau of Labor Statistics, reported 153 work stoppages in 1963 in certain mineral industry groups, with a total of approximately 791,000 man-days of work lost. Although the number of stoppages decreased only 7 percent from 1962, there was a 45-percent decrease in worktime loss. The bituminous coal mining industry had 131 work stoppages in 1963, and anthracite had 4. The worktime lost in the two industries was 234,000 and 3,000 man-days respectively. The copper mining and crushed stone industries each had 5 stoppages with respective man-day losses of 27,600 and 3,800; 1 stoppage in the petroleum refining industry resulted in 314,000 work-days lost; the number of work stoppages in the lead-zinc and chemical and fertilizer minerals industries was not available, but work-days lost were 91,700 and 88,600 respectively; 1 stoppage each in iron and gold-silver mining industries accounted for work-day losses of 2,400 and 16,000. Work-day losses were less than 1,000 man-days for 2 stoppages in the sand and gravel industry, for 1 in the dimension stone industry, and 1 in the cement industry.

TABLE 2.—Work stoppages in certain mineral industries in the United States

Industry and year	Work stoppages	
	Number	Man-days lost (thousands)
Coal mining:		
Anthracite:		
1959	1	1.2
1960	6	9.3
1961	5	4.2
1962	8	14.6
1963	4	3.0
Bituminous:		
1959	146	[1] 1,560.0
1960	120	[1] 137.0
1961	117	90.7
1962	121	191.0
1963	131	[1] 234.0
Coke and byproducts, Coke only:		
1959	[2]	[2]
1960	[2]	[2]
1961	[2]	[2]
1962	[2]	[2]
1963	[2]	[2]
Petroleum refining:		
1959	13	543.0
1960	2	[1] 48.2
1961	9	310.0
1962	5	516.0
1963	1	[1] 314.0
Metal mining:		
Iron:		
1959	8	2,120.0
1960	2	15.2
1961	2	4.2
1962	3	17.4
1963	1	[1] 2.4
Copper:		
1959	9	1,800.0
1960	1	[1] 361.0
1961	4	106.0
1962	5	129.0
1963	5	27.6
Lead-zinc:		
1959	5	28.0
1960	3	58.0
1961	4	18.0
1962	4	160.0
1963	------	[1] 91.7
Gold-silver:		
1959	------	----------
1960	------	----------
1961	1	2.1
1962	1	8.8
1963	1	16.0
Bauxite and other aluminum ores:		
1959	------	----------
1960	------	----------
1961	------	----------
1962	------	----------
1963	------	----------
Ferroalloy metal ores:		
1959	1	[3]
1960	1	[3]
1961	1	5.5
1962	1	211.0
1963	1	[1] 9.6
Metal mining services:		
1959	1	[3]
Metal mining services—Con.		
1960	------	----------
1961	------	----------
1962	------	----------
1963	------	----------
Miscellaneous metal ores:		
1959	2	2.0
1960	2	2.3
1961	2	44.4
1962	------	----------
1963	------	----------
Mining and quarrying of nonmetallic minerals (except fuels):		
Dimension stone:		
1959	------	----------
1960	1	2.5
1961	1	2.6
1962	3	74.5
1963	1	[3]
Crushed and broken stone:		
1959	8	76.9
1960	13	104.0
1961	7	2.8
1962	4	6.3
1963	5	3.8
Sand and gravel:		
1959	3	[1] 11.1
1960	3	1.8
1961	4	4.3
1962	3	2.0
1963	2	[3]
Clay, ceramic and refractory minerals:		
1959	2	1.2
1960	------	----------
1961	2	1.9
1962	1	[3]
1963	------	----------
Chemical and fertilizer mineral mining:		
1959	3	45.5
1960	2	7.3
1961	3	17.6
1962	5	169.0
1963	------	[1] 88.6
Nonmetallic minerals (except fuels) services:		
1959	------	----------
1960	------	----------
1961	------	----------
1962	------	----------
1963	------	----------
Miscellaneous nonmetallic minerals (except fuels):		
1959	------	----------
1960	------	----------
1961	------	----------
1962	------	----------
1963	------	----------
Cement, hydraulic:		
1959	8	74.8
1960	2	[1] 3.6
1961	5	4.9
1962	1	[3]
1963	1	[3]

[1] Includes idleness from stoppages which began in previous year.
[2] Data not available.
[3] Less than 1,000 man-days.

Source: U.S. Department of Labor, Bureau of Labor Statistics.

TABLE 3.—Employment and injury experience in the mineral industries

Year	Men working	Man-hours worked	Number of injuries		Injury rate per million man-hours	
			Fatal	Nonfatal	Fatal	Nonfatal
1931	784,347	1,288,135,808	1,707	94,021	1.33	72.99
1932	671,343	962,924,915	1,368	66,028	1.42	68.57
1933	677,722	1,058,245,650	1,242	70,158	1.17	66.30
1934	739,817	1,167,723,543	1,429	79,211	1.22	67.83
1935	783,139	1,215,316,764	1,495	80,070	1.23	65.88
1936	824,514	1,426,233,543	1,686	90,608	1.18	63.53
1937	859,951	1,482,241,908	1,759	94,466	1.19	63.73
1938	774,894	1,144,137,296	1,369	69,940	1.20	61.13
1939	788,925	1,251,169,210	1,334	73,253	1.07	58.55
1940	801,926	1,385,128,234	1,716	80,856	1.24	58.37
1941	835,095	1,541,335,277	1,621	87,911	1.05	57.04
1942 [1]	1,120,450	2,319,213,897	1,970	100,861	.85	43.49
1943	1,144,831	2,555,619,729	1,953	101,164	.76	39.58
1944	1,086,103	2,573,452,816	1,751	98,066	.68	38.11
1945	1,033,035	2,363,783,323	1,414	87,578	.60	37.05
1946	1,108,517	2,275,960,528	1,336	86,291	.59	37.91
1947	1,179,835	2,469,256,565	1,556	91,311	.63	36.98
1948	1,242,241	2,530,418,226	1,383	86,295	.55	34.10
1949	1,240,330	2,256,418,166	898	65,909	.40	29.21
1950	1,237,649	2,340,954,733	952	66,729	.41	28.51
1951	1,223,639	2,418,090,394	1,122	67,285	.46	27.83
1952	1,230,692	2,383,608,034	927	61,296	.39	25.72
1953	1,193,182	2,357,970,591	817	53,992	.35	22.90
1954	1,096,423	2,138,687,112	671	43,130	.31	20.17
1955 [2]	1,122,393	2,290,057,680	729	46,197	.32	20.17
1956 [3]	1,113,471	2,294,678,414	788	45,454	.34	19.81
1957 [4]	1,187,052	2,409,969,589	810	45,898	.34	19.05
1958 [5]	1,129,638	2,208,298,487	656	39,925	.30	18.08
1959	1,106,534	2,194,901,514	597	37,750	.27	17.20
1960	1,045,111	2,082,521,189	603	36,044	.29	17.31
1961	951,378	1,913,481,071	542	34,173	.28	17.86
1962	950,876	1,917,475,219	647	33,067	.34	17.25
1963 [6]	927,000	1,902,520,526	565	32,689	.30	17.18

[1] Includes oil and gas beginning with 1942.
[2] Clay mines and nonmetal mills included beginning with 1955.
[3] Clay mills included beginning with 1956.
[4] Peat and sand and gravel included beginning with 1957.
[5] Slag included beginning with 1958.
[6] Preliminary figures.

NATIONAL SAFETY COMPETITIONS

Nationwide safety competitions are conducted annually by the Bureau of Mines to encourage the development of safe working conditions and safe working habits at mineral producing plants. Operations achieving outstanding safety records receive national recognition. Such recognition aids in the formulation of more effective accident-prevention programs. One thousand eight hundred and three plants participated in the 1963 competitions, and of these 915 (51 percent) were injury-free. The injury-free operations worked 48,274,475 man-hours (23 percent) of the total man-hours worked by all participating plants.

The National Safety Competition is sponsored jointly by the Bureau of Mines and the American Mining Congress. The 1963 competition had a record number of 963 participants, 53 more than 1962. Four hundred thirty-five or 45 percent of the contestants were injury-free during the contest year. The injury-free plants worked 29,496,030 man-hours, 18 percent of the total man-hours.

Awards of the "Sentinels of Safety" trophies and certificates for the best safety records in each of the six groups in the 1963 National Safety Competition were made to the following companies:

Bituminous Coal Mines (Underground).—Karen Mine, United States Steel Corp., Fredericktown, Pa.

Anthracite Mines (Underground).—Phillips Slope Mine, Trevorton, Pa.

Metal Mines (Underground).—Mesa Creek Mine, Union Carbide Nuclear Co., Uravan, Colo.

Open-Pit Mines.—Peter Mitchell Mine, Reserve Mining Company, Babbitt, Minn.

Nonmetal Mines (Underground).—Bellefonte Mine, National Gypsum Company, Bellefonte, Pa.

Quarries.—Port Inland Quarry, Inland Lime and Stone Co., Gulliver, Mich.

The National Sand and Gravel Competition is sponsored solely by the Bureau. Three hundred thirty-eight plants were enrolled in the competition, and 226 (67 percent) were injury-free. Although the frequency rate of 21.724 increased 12 percent over 1962, the severity rate was decreased by 24 percent. The Bureau also sponsors a contest for Oilwell Drilling Contractors. This new competition had 12 participants, who worked a total of 1,018,012 man-hours. Forty-two percent of the participants were injury-free.

The Bureau of Mines conducted four other annual competitions, which were co-sponsored by national associations connected with the mineral industries—the National Crushed Stone Association, National Lime Association, the National Slag Association, and the National Limestone Institute. In 1963, 490 plants participated in these contests, and 249 plants (51 percent) were injury-free. Man-hours worked by the total enrollment were 37,623,702; plants with injury-free records worked 14,120,232 man-hours, 38 percent of the total.

The Mineral Industry of Alabama

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Alabama for collecting information on all minerals except fuels.

By Avery H. Reed, Jr.[1] and Thomas A. Simpson[2]

RECORD production of crude petroleum, lime, crushed marble, and talc highlighted the mineral industry of Alabama in 1963. Among the States, Alabama ranked second in the production of bauxite, third in the production of scrap mica and native asphalt, and fifth in iron ore.

The mineral industry of Alabama was dominated by mining and processing coal and stone, the manufacture of cement, and the production of crude petroleum, which together comprised 86 percent of the total value of production, compared with 82 percent in 1962. The iron-ore industry continued to decline; in 1959 the value of iron ore produced was 12 percent of the total State production value; in 1960, 11 percent; in 1961, 10 percent; in 1962, 8 percent; and in 1963, 5 percent.

TABLE 1.—Mineral production in Alabama[1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry—thousand 280-pound barrels	2,187	$6,521	2,386	$7,242
Portland—thousand 376-pound barrels	12,482	40,164	12,218	38,417
Clays[2]—thousand short tons	1,632	1,947	1,607	3,003
Coal (bituminous)—do.	12,880	95,149	12,359	91,243
Gem stones			(3)	2
Iron ore (usable)—thousand long tons, gross weight	2,962	17,838	2,126	11,806
Lime—thousand short tons	522	6,298	596	6,974
Natural gas—million cubic feet	128	13	177	21
Petroleum (crude)—thousand 42-gallon barrels	7,473	19,355	[4] 9,175	[4] 23,763
Sand and gravel—thousand short tons	4,655	4,486	5,363	5,778
Stone[5]—do.	12,680	19,667	13,684	22,206
Value of items that cannot be disclosed: Asphalt (native), bauxite, slag cement, kaolin, mica, salt, stone (1962 dimension limestone, dimension marble, oystershell, crushed sandstone, and 1963 shell), and talc		8,347		5,415
Total		[6] 219,785		215,870

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes kaolin; included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Preliminary figure.
[5] Excludes certain stone; included with "Value of items that cannot be disclosed."
[6] Revised figure.

[1] Supervising mining engineer, Bureau of Mines, Knoxville, Tenn.
[2] Chief, Economic Geology Division, Geological Survey of Alabama, Tuscaloosa, Ala.

747-416—64——5

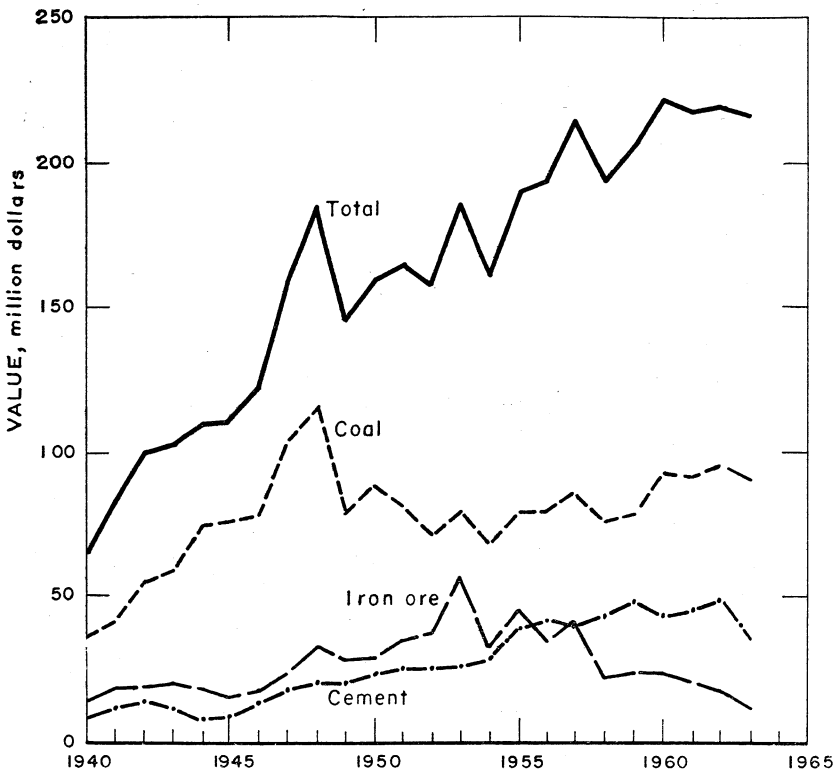


FIGURE 1.—Value of coal, cement, and iron ore, and total value of mineral production in Alabama, 1940–63.

The total value of mineral production decreased 2 percent below the record established in 1962, owing to decreases in the production of coal and iron ore.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$175,758	1958	$194,053
1953	201,441	1959	205,416
1954	169,443	1960	225,882
1955	199,343	1961	224,815
1956	198,712	1962	228,652
1957	213,605	1963	223,958

Trends and Developments.—Alabama Power Co. was making surveys and acquiring rights-of-ways for approximately $40 million worth of redevelopment on Jordan Dam on Lake Jordan. The redevelopment will include raising the present dam 7 feet, building a second generating plant, and constructing an intake canal. It will take approximately 4 years to complete the project. About 245 miles of Federal interstate controlled-access highways were in use in Alabama at yearend. By December 1966, about 479 miles will be opened to traffic. The program has scheduled 871 miles of these superhighways for Alabama. Of this, 152 miles were under construction, 240 miles were in the planning stage, and preliminary engineering was underway for the remaining miles at yearend.

Legislation and Government Programs.—The Bureau of Mines operated the Tuscaloosa Metallurgy Research Center at Tuscaloosa, working on research problems concerned with mineral industries. The Bureau's Area II Mineral Resource Field Office at Tuscaloosa worked on iron ore and coal resource projects in the Southeast.

Water.—During 1963 the Bureau of Mines canvassed the mineral producers for water used in the mineral industries in 1962. The results of the canvass indicate that most of the water used in Alabama was by the large bituminous coal washing plants. Of the total water used, nonmetal mines and mills used 4 percent, sand and gravel mines used 6 percent, quarries and mills used 6 percent, metal mines and mills used 25 percent, and bituminous coal cleaning plants used 59 percent. Of the total water used, 60 percent was recirculated. Eleven million gallons were used in oil and gas drilling.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Industry	New water	Recirculated water	Total water use
Coal (bituminous)	2,330	7,363	9,693
Metal mines and mills	3,304	853	4,157
Quarries and mills	484	579	1,063
Sand and gravel mines	163	796	959
Nonmetal mines and mills	357	259	616
Petroleum and natural gas	11		11
Total	6,648	9,851	16,499

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Asphalt (Native).—Alabama Asphaltic Limestone Co. (Margerum quarry) crushed bituminous limestone in Colbert County for roadstone; production increased 31 percent. Alabama ranked third among the States in the production of native asphalt.

Coal (Bituminous).—Bituminous coal was mined at 180 mines in 10 counties, compared with 186 mines in 10 counties in 1962. The leading counties were Jefferson, Walker, and Shelby. The leading companies were Southeastern Electric Generating Co., Tennessee Coal & Iron, Alabama By-Products Corp., Woodward Iron Co., and U.S.

Pipe & Foundry Co., which together supplied 63 percent of the State total. Production decreased 4 percent and was 41 percent below the 1926 record. The average output per mine decreased from 69,200 tons in 1962 to 68,700. Captive tonnage was 58 percent of the total, compared with 59 percent in 1962.

Underground mines produced 74 percent of the total production, strip mines 25 percent, and auger mines 1 percent. Eighty-five percent of the coal was shipped by rail or water, 6 percent by conveyor belt, and 9 percent by truck.

Ninety-three percent of the coal mined underground was mechanically loaded; 83 mobile loading machines loaded 87 percent, 2 continuous-mining machines loaded 1 percent, and 4 self-loading conveyors and 56 face conveyors loaded 2 percent.

TABLE 4.—Coal (bituminous) production, by counties

County	1962		1963[1]	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Bibb	43,211	$224	80,018	$443
Blount	(1)	(1)	95,808	526
Cullman	9,850	58	11,000	69
Jackson	15,050	104	19,073	145
Jefferson	6,811,551	53,438	6,691,601	52,471
Marion	243,820	977	354,954	2,025
Shelby	533,735	4,634	544,518	4,758
Tuscaloosa	693,131	3,258	482,735	2,112
Walker	4,270,518	31,198	3,965,282	28,083
Winston	(1)	(1)	113,973	611
Undistributed	258,794	1,258		
Total	12,879,660	95,149	12,358,962	91,243
Earliest record to date	985,440,000	(2)	997,799,000	(2)

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Data not available.

Equipment used at 129 underground mines included 150 cutting machines, which cut 98 percent of the tonnage; 201 power drills, which drilled 97 percent; 130 locomotives; 27 tractors; 177 shuttle cars; and 72 mother conveyors.

Equipment used at 46 strip mines included 72 power shovels, 17 draglines, 5 carryall scrapers, 66 bulldozers, 28 power drills, and 90 trucks. An estimated 60 million cubic yards of overburden were removed.

Six coal-recovery augers, 1 bulldozer, and 24 trucks were used at 5 auger mines.

Of the total production of coal, 85 percent was cleaned at 31 cleaning plants.

Coke.—Six companies produced byproduct metallurgical coke at seven plants in Jefferson, Etowah, and Tuscaloosa Counties. Leading coke producers were Tennessee Coal & Iron Division of United States Steel Corp. and U.S. Pipe & Foundry Co.

Natural Gas.—Marketed production of natural gas from Marion County was about the same as in 1962.

Petroleum.—Production of crude petroleum increased 23 percent above the record established in 1962. Leading counties were Mobile and Escambia. During 1963, 48 new producing wells were drilled. The 492 producing wells were in the following counties: Baldwin, 6; Choctow, 55; Clarke, 12; Escambia, 29; and Mobile, 390. During the year, 93 wells totaling 992,000 feet were drilled.

TABLE 5.—Crude petroleum production, by counties

(Barrels)

County	1962	1963 [1]
Baldwin	40,459	42,500
Choctaw	268,555	265,613
Clarke	132,906	128,923
Escambia	574,021	517,639
Mobile	[2] 6,457,059	8,230,320
Total	[2] 7,473,000	9,175,000
Earliest record to date	[2] 48,203,000	57,378,000

[1] Preliminary figures.
[2] Revised figure.

Source: State Oil and Gas Board.

NONMETALS

Cement.—Eight companies produced masonry cement at nine plants in five counties. Leading producers were Southern Cement Co. and Ideal Cement Co. Shipments increased 9 percent, but were 8 percent below the 1955 record. Consumption of masonry cement in Alabama was 24 percent of the total shipments. Out-of-State shipments were made to Georgia (34 percent), Florida (10 percent), South Carolina (9 percent), Mississippi (6 percent), North Carolina (6 percent), Louisiana (5 percent), Tennessee (4 percent), and other States (2 percent).

Seven companies produced portland cement at eight plants in five counties. Leading producers were Ideal Cement Co. (Mobile plant) and Lone Star Cement Corp. (Birmingham and Demopolis plants). Shipments decreased 2 percent and were 6 percent below the 1959 record. Consumption of portland cement in Alabama was 37 percent of shipments. Out-of-State shipments were made to Georgia (22 percent), Mississippi (13 percent), Florida (11 percent), South Carolina (6 percent), Louisiana (4 percent), Tennessee (3 percent), and other States (4 percent). Raw materials used in manufacturing portland cement included limestone and oystershell (58 percent), cement rock (23 percent), clay and shale (12 percent), and other materials (7 percent).

Fifty-four percent of the portland cement was used for ready-mixed concrete; concrete-products manufacturers used 19 percent, highway contractors 10 percent, building materials dealers 9 percent, and other uses 8 percent. The annual capacity of portland cement plants was unchanged at 16.3 million barrels.

Southern Cement Co. and Cheney Lime & Cement Co. produced slag cement. Shipments decreased 6 percent and were 75 percent below the record established in 1952.

Clays.—Nine companies mined fire clay at 11 mines in 6 counties. Leading producers were Donoho Clay Co. and Natco Corp. Production was about the same as in 1962 and was 27 percent below the 1956 record. Twenty-one companies mined 1,387,000 tons of miscellaneous clay at 22 mines in 12 counties for use in heavy clay products and portland cement. Leading producers were Bickerstaff Brick Co. Inc. and Jenkins Brick Co. Production decreased 2 percent and was 10 percent below the 1960 record. Harbison-Walker Refractories Co. and Thomas Alabama Kaolin Co. mined kaolin in Henry and Marion Counties. Production declined 48 percent below the record established in 1962.

Natco Corp. announced a modernization and expansion program at its Cordova, Ala. plant. When completed, the plant will be one of the most modern of its type in the country. It will manufacture a complete line of glazed and unglazed face tile and brick.

TABLE 6.—Fire clay sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Foundries and steelworks	134,245	$441,812	$3.29	167,900	$1,611,293	$9.60
Mortar	6,665	33,349	5.01	7,972	24,480	3.07
Firebrick and block	19,989	51,200	2.56	3,342	10,230	3.06
Other [1]	61,747	157,344	2.55	41,368	109,480	2.65
Total	222,646	683,705	3.07	220,582	1,755,483	7.96

[1] Includes bauxite, high-alumina brick, and heavy clay products.

Gem Stones.—Several amateur collectors reported collecting various mineral specimens throughout the State.

Lime.—Six companies produced quicklime and hydrated lime at seven plants in Shelby and Dallas Counties for building, agricultural, chemical, and industrial uses. Leading producers were Southern Cement Co. (Roberta and Keystone limekilns) and Longview Lime Corp. Production increased 15 percent and surpassed the 1961 record by 3 percent. Consumption of lime in Alabama was 53 percent of total shipments. Out-of-State shipments were made to Florida (16 percent), Georgia (16 percent), Mississippi (6 percent), Tennessee (5 percent), Louisiana (3 percent), exports (1 percent), and other States (3 percent).

Six companies recovered quicklime at byproduct plants at seven papermills in six counties. Leading producers of regenerated lime were International Paper Co. and Scott Paper Co., operating in Mobile County.

Mica.—Dixie Mines, Inc., mined scrap mica at the Dixie mine. Production decreased 4 percent below the record established in 1962. Alabama ranked third among the States in the production of scrap mica. Part of the scrap mica was ground in Alabama, and part was shipped to Texas for fine grinding.

TABLE 7.—Lime sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Chemical and industrial	412,917	$4,337,820	$11.72	479,886	$5,425,263	$11.31
Other [1]	108,719	1,460,570	13.43	116,115	1,548,981	13.34
Total	521,636	6,298,390	12.07	596,001	6,974,244	11.70

[1] Includes construction and agricultural lime.

Salt.—Olin Mathieson Chemical Corp. produced salt from brine in Washington County. Production increased 11 percent but was 3 percent below the 1960 record.

Sand and Gravel.—Thirty-five companies mined sand and gravel at 38 mines in 25 counties. The leading counties were Montgomery, Macon, and Mobile. Leading producers were Birmingham Slag (Montgomery and Macon Counties), Alabama Gravel Co. (Elmore and Montgomery Counties), and Radcliff Materials, Inc. (Mobile County). Production increased 15 percent but was 8 percent below the 1961 record. Virtually the entire production was processed. Forty-eight percent of the total production was shipped by truck, 40 percent by rail, and 12 percent by water. Of the total production, 21 percent was produced at portable plants.

TABLE 8.—Sand and gravel sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Baldwin	16,212	$30,967		
Barbour	13,446	23,114	17,816	$30,617
Calhoun	(1)	(1)		
Cherokee	1,881	4,461	(1)	(1)
Clarke	(1)	(1)	47,037	53,386
Conecuh	55,220	55,580	(1)	(1)
Covington			(1)	(1)
Dallas	160,596	160,596	212,681	212,681
Etowah			138,325	172,300
Geneva			(1)	(1)
Greene	(1)	(1)		
Jefferson	(1)	(1)		
Macon	(1)	(1)	705,502	952,612
Mobile	499,171	499,171	676,569	674,991
Monroe	36,400	32,000	42,349	44,118
Montgomery	1,588,061	1,320,612	1,292,472	1,202,575
Russell	(1)	(1)	136,900	169,715
Washington			(1)	(1)
Winston			(1)	(1)
Undistributed [2]	2,283,619	2,359,185	2,093,138	2,265,293
Total	4,654,606	4,485,686	5,362,789	5,778,288

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes Autauga, Chilton, Dale, Elmore, Escambia, Franklin, Houston, Morgan, Talladega, and Tuscaloosa Counties and counties indicated by footnote 1.

TABLE 9.—Sand and gravel sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	1,212,956	$959,626	$0.79	1,350,164	$1,268,395	$0.94
Paving	563,485	427,346	.76	795,572	676,706	.85
Engine	98,786	98,759	1.00	(1)	(1)	(1)
Fill	45,510	27,172	.60	33,366	28,085	.84
Railroad ballast	(2)	(2)	(2)	1,000	500	.50
Other uses	(2)	(2)	(2)	[3] 205,147	[3] 333,677	[3] 1.63
Total	(2)	(2)	(2)	2,385,249	2,307,363	.97
Gravel:						
Paving	1,407,165	1,353,833	.96	1,435,531	1,643,638	1.14
Structural	845,609	952,913	1.13	1,221,243	1,486,217	1.22
Fill	24,990	29,112	1.16	7,470	9,235	1.24
Other uses	(2)	(2)	(2)	[4] 313,296	[4] 331,835	[4] 1.06
Total	(2)	(2)	(2)	2,977,540	3,470,925	1.17
Total sand and gravel	[5] 4,654,606	[5] 4,485,686	[5] .96	5,362,789	5,778,288	1.08

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Total sand and gravel."
[3] Includes molding, filtration, other uses, and uses indicated by footnote 1.
[4] Includes railroad ballast and other gravel.
[5] Includes railroad ballast, molding, filtration, and other sands, and railroad ballast and other gravel.

Stone.—Thirty-five companies crushed limestone at 42 quarries in 17 counties. The principal producing counties were Shelby, Jefferson, Madison, and Colbert. Leading producers were Madison Limestone Co., Birmingham Slag Co., Lone Star Cement Corp., and Southern Cement Co. Production increased 8 percent but was 1 percent below the 1961 record. Of the total production, 53 percent was shipped by truck, 26 percent by rail, 15 percent by conveyor belt, and 6 percent by water.

Alabama Limestone Co. and Sisson Bros. Stone Co. quarried dimension limestone in Franklin and Blount Counties for rubble, rough architectural stone, dressed building stone, and curbing and flagging. Production increased 59 percent but was 31 percent below the 1956 record.

Thompson-Weinman & Co., Moretti-Harrah Marble Co., and Georgia Marble Co. crushed marble at Sylacauga for whiting, terrazzo, and other uses. Production increased 8 percent above the 1962 record.

Moretti-Harrah Marble Co. and Georgia Marble Co. quarried dimension marble at Sylacauga for rough and dressed building stone and for dressed monumental stone. Production decreased 37 percent below the 1962 record.

Radcliff Materials, Inc., and Southern Oystershell Milling Corp. crushed oystershells from Mobile Bay for cement, concrete and roads, and poultry grit. Production decreased 29 percent and was 48 percent below the 1947 record.

TABLE 10.—Crushed limestone sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Calhoun			(1)	(1)
Colbert	1,145,529	$1,332,122	1,008,057	$1,281,340
Henry	16,840	62,000	10,000	30,000
Jackson			(1)	(1)
Jefferson	2,979,469	3,393,744	2,927,389	3,329,719
Limestone	52,663	78,949	65,217	97,825
Shelby	3,470,376	4,850,971	4,035,536	5,431,205
Undistributed [2]	4,660,308	5,004,821	5,209,275	5,689,032
Total	12,325,185	14,722,607	13,255,474	15,859,121

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes Conecuh, Covington, De Kalb, Etowah, Franklin, Madison, Marengo, Marshall, Morgan, St. Clair, Talladega, and Washington Counties and counties indicated by footnote 1.

Universal Atlas Cement Co., Sam P. Acton, Enos Vann, and Brookshire & Kirkland Sandstone Co. crushed sandstone for cement, refractory, and other uses. Production decreased 9 percent and was 90 percent below the 1956 record. Brookshire & Kirkland quarried a small quantity of dimension sandstone for dressed building stone in Marshall County.

METALS

Aluminum.—Reynolds Metals Co. operated the Listerhill aluminum reduction plant at Sheffield.

Bauxite.—Harbison-Walker Refractories Co., R. E. Wilson Mining Co., and Wilson-Sneed Bauxite Co. mined crude bauxite in Barbour and Henry Counties for refractories and chemicals. Production increased 38 percent. Alabama ranked second among the States in the production of bauxite, moving up from third place in 1962.

Copper.—A major copper producing company conducted an intensive diamond drilling program in Clay County. Results of the drilling program have not been announced.

Ferroalloys.—Shipments of ferromanganese, silicomanganese, ferrosilicon, and ferrophosphorus amounted to 117,000 tons valued at $16 million.

Iron Ore.—Total shipments of iron ore declined 28 percent and were 76 percent below the 1942 record. Shipments were the lowest since 1932. Of the total shipments, 15 percent was direct-shipping ore, compared with 31 percent in 1962 and 44 percent in 1961. The number of operating mines decreased from 27 to 25, and the average usable production per mine decreased from 110,000 tons to 85,000 tons. Alabama ranked fifth among the States in the production of iron ore.

Woodward Iron Co. and Southeastern Coal & Iron Co., a company owned by Woodward Iron Co., mined red iron ore (hematite) at the Pyne mine in Jefferson County and the Dudley mine in Tuscaloosa County. Total production declined 40 percent and was 86 percent below the 1942 record.

TABLE 11.—Crushed limestone sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	5,709 150	$7,175,181	$1.26	6,318,326	$7,929,287	$1.25
Cement manufacture	3,471,156	2,476,977	.71	3,641,747	2,516,619	.69
Lime manufacture	888,879	1,170,011	1.32	1,029,498	1,409,280	1.37
Fluxing stone	979,585	1,606,443	1.64	947,197	1,601,898	1.69
Agstone	591,626	986,669	1.67	498,363	845,227	1.70
Riprap	196,647	233,172	1.19	356,580	483,599	1.36
Rockdust for coal mines	62,401	255,380	4.09	78,597	326,108	4.15
Asphalt filler	(1)	(1)	(1)	47,151	203,881	4.32
Stone sand	(1)	(1)	(1)	21,119	26,808	1.27
Paper	30,603	72,686	2.38	(1)	(1)	(1)
Other uses [2]	395,138	746,088	1.89	316,896	516,414	1.63
Total	12,325,185	14,722,607	1.19	13,255,474	15,859,121	1.20

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes refractory stone, railroad ballast, alkali, other fillers, other uses, and uses indicated by footnote 1.

Twenty-two operators mined brown iron ore (limonite) at 24 mines in 10 counties. Leading counties were Butler, Franklin, and Pike. Leading producers were Glenwood Mining Co. Inc. (Butler and Pike Counties), U.S. Pipe & Foundry Co. (Franklin County), and Shook & Fletcher Supply Co. (Blount and Franklin Counties). Production decreased 8 percent and was 46 percent below the 1942 record.

Magnesium.—Alabama Metallurgical Corp. produced magnesium metal from dolomite at Selma.

Pig Iron and Steel.—Tennessee Coal & Iron, Republic Steel Corp., Woodward Iron Co., and U.S. Pipe & Foundry Co. produced 3,899,000 tons of basic, foundry, and malleable pig iron, compared with 3,628,000 tons in 1962. Value of shipments was $217 million, compared with $207 million in 1962. Iron ore consumed in agglomerating plants, blast furnaces, and steel furnaces was 50 percent domestic and 50 percent imported. Imports of iron ore, chiefly from Venezuela, Canada, Peru, and Liberia, increased 29 percent, but were 40 percent below the 1959 record.

TABLE 12.—Usable iron ore production and shipments

	1962		1963	
	Long tons	Iron content, natural (percent)	Long tons	Iron content, natural (percent)
Production:				
Hematite	1,825,110	37	1,102,735	38
Limonite	1,152,816	47	1,062,265	47
Shipments:				
Direct-shipping ore	917,795	37	327,619	38
Concentrates and sinter	2,044,213	47	1,798,294	47

TABLE 13.—Usable iron ore shipments, by counties

County	1962		1963	
	Long tons	Value	Long tons	Value
Butler	366,540	$1,941,130	458,945	$2,237,324
Pike	291,433	1,396,625	176,591	823,050
Undistributed [1]	2,304,035	14,500,551	1,490,377	8,745,300
Total	2,962,008	17,838,306	2,125,913	11,805,674

[1] Includes the following counties for which figures are withheld to avoid disclosing individual company confidential data: Barbour, Blount, Calhoun, Cherokee (1963), Crenshaw, Franklin, Jefferson, Shelby, Talladega, and Tuscaloosa.

TABLE 14.—Mine production and shipments of crude iron ore

	1962		1963	
	Number of mines	Long tons	Number of mines	Long tons
Mine production:				
By varieties:				
Hematite	3	1,965,613	2	1,285,099
Limonite	24	4,559,300	23	4,247,550
By mining methods:				
Open pit	25	4 619 948	24	4 318,659
Underground	2	1,904,965	1	1,213,990
Shipments from mines:				
Direct to consumers	3	917,795	2	327,619
To beneficiation plants	26	5,609,786	25	5,205,652

REVIEW BY COUNTIES

Mineral production was reported from 53 of the 67 counties, compared with 48 in 1962. The major producing counties were Jefferson, Mobile, Walker, and Shelby, which together furnished 79 percent of the total State value.

Autauga.—Dallas Sand & Gravel Co. Inc. mined building, paving, and fill sand and building, paving, and fluxing gravel.

Baldwin.—Production of crude petroleum from six wells increased 5 percent; two new wells totaling 26,500 feet were drilled. Fairhope Clay Products Co. mined miscellaneous clay for heavy clay products.

Barbour.—Production of brown iron ore by H. D. Loflin and B & C Construction Co. increased 82 percent. R. E. Wilson Mining Co. and Wilson-Sneed Mining Co. mined bauxite for chemicals and refractories. McKenzie Construction Co. mined building and paving sand and gravel.

Bibb.—Seven coal mines were active; leading producers were Bibb Mining Co. (Bibb No. 1 strip mine) and Fitts & Gay Coal Co. (No. 1 strip mine). David E. Corn collected a few mineral specimens.

Blount.—Shook & Fletcher Supply Co. mined brown iron ore at the Champion mine. Robbins Coal Co. Inc. mined coal at the Southview strip mine. Chaney Lime & Cement Co. produced masonry and slag cements at the Graystone mill. Sisson Bros. Stone Co. opened the M & H Quarry and produced dimension limestone, which was used for rough architectural and dressed building stone and for curbing

and flagging. Harbison-Walker Refractories Co. (Thermal mine) and Lehigh Coal Co. mined fire clay for refractories.

Butler.—Eight companies mined brown iron ore. Leading producers were Glenwood Mining Co. Inc., Pigeon Creek Mining Co., and Woodward-Acree Mining Co.

TABLE 15.—Value of mineral production in Alabama, by counties[1]

County	1962	1963	Minerals produced in 1963 in order of value
Autauga	(2)	(2)	Sand and gravel.
Baldwin	(2)	(2)	Petroleum, miscellaneous clay.
Barbour	(2)	(2)	Iron ore, bauxite, sand and gravel.
Bibb	$223,699	$443,454	Coal, gem stones.
Blount	1,294,074	1,437,366	Iron ore, coal, cement, limestone, fire clay.
Butler	1,941,130	2,237,324	Iron ore.
Calhoun	(2)	(2)	Fire clay, limestone, iron ore, miscellaneous clay, gem stones.
Cherokee	4,461	(2)	Iron ore, sand and gravel, gem stones.
Chilton	(2)	(2)	Sand and gravel.
Choctaw	(2)	(2)	Petroleum.
Clarke	(2)	(2)	Petroleum, sand and gravel, gem stones.
Clay	----------	45	Gem stones.
Cleburne	----------	60	Do.
Colbert	(2)	(2)	Limestone, native asphalt.
Conecuh	(2)	(2)	Sand and gravel, limestone.
Coosa	----------	370	Gem stones.
Covington	(2)	(2)	Limestone, sand and gravel.
Crenshaw	(2)	(2)	Iron ore.
Cullman	58,346	69,040	Coal.
Dale	(2)	(2)	Sand and gravel.
Dallas	(2)	(2)	Lime, sand and gravel.
De Kalb	(2)	(2)	Limestone.
Elmore	(2)	(2)	Sand and gravel, miscellaneous clay, gem stones.
Escambia	(2)	(2)	Petroleum, sand and gravel, miscellaneous clay.
Etowah	(2)	(2)	Limestone, sand and gravel, miscellaneous clay.
Franklin	2,617,952	2,904,820	Limestone, iron ore, sand and gravel, fire clay.
Geneva	----------	(2)	Sand and gravel.
Greene	(2)	----------	
Henry	(2)	(2)	Bauxite, kaolin, limestone.
Houston	(2)	(2)	Sand and gravel.
Jackson	104,447	(2)	Coal, limestone.
Jefferson	93,438,474	86,298,859	Coal, cement, iron ore, limestone, miscellaneous clay, sandstone, fire clay, gem stones.
Lee	----------	45	Gem stones.
Limestone	78,949	97,825	Limestone.
Macon	(2)	952,612	Sand and gravel.
Madison	(2)	(2)	Limestone, miscellaneous clay, gem stones.
Marengo	(2)	(2)	Cement, limestone.
Marion	(2)	(2)	Coal, kaolin, natural gas.
Marshall	(2)	(2)	Limestone, sandstone.
Mobile	(2)	(2)	Petroleum, cement, oystershell, sand and gravel, miscellaneous clay.
Monroe	32,000	44,118	Sand and gravel.
Montgomery	(2)	(2)	Sand and gravel, miscellaneous clay.
Morgan	(2)	(2)	Limestone, sand and gravel.
Pike	1,396,625	823,050	Iron ore.
Randolph	(2)	(2)	Mica.
Russell	(2)	565,965	Miscellaneous clay, sand and gravel.
St. Clair	(2)	(2)	Cement, limestone, miscellaneous clay, fire clay.
Shelby	22,958,935	23,922,751	Cement, lime, limestone, coal, miscellaneous clay, iron ore, gem stones.
Talladega	(2)	(2)	Marble, limestone, sand and gravel, talc, iron ore, gem stones.
Tallapoosa	----------	65	Gem stones.
Tuscaloosa	(2)	(2)	Coal, iron ore, sand and gravel, gem stones.
Walker	(2)	(2)	Coal, fire clay.
Washington	(2)	(2)	Limestone, salt, sand and gravel.
Winston	(2)	(2)	Coal, sand and gravel, gem stones.
Undistributed	[3] 95,635,908	96,252,231	
Total	[3] 210,785,000	215,870,000	

[1] The following counties are not listed because no production was reported: Bullock, Chambers, Coffee, Fayette, Hale, Lamar, Lauderdale, Lawrence, Lowndes, Perry, Pickens, Sumter, and Wilcox.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Revised figure.

Calhoun.—Donoho Clay Co., Dixie Clay Co., and Leroy Lackey mined fire clay for refractories. Hodges & Co. quarried limestone near Anniston for concrete and roads. Pope Mining Co. and Fred Brown Mining Co. mined brown iron ore. Agricola Frame Brick Co. mined miscellaneous clay for heavy clay products. Leon McCluer collected a few mineral specimens.

Cherokee.—Trotter and Ingram Mining Co. (Weems mine) mined brown iron ore. Wolf Creek Sand Co. mined molding sand. William C. Whitehouse and John Garvin collected several mineral specimens.

Chilton.—Southeastern Sand & Gravel Co. Inc. (Plantersville mine) and Wade Sand & Gravel Co. mined building, paving, filtration, fill, and engine sand and building, paving, fill, and other gravel.

Choctaw.—Crude petroleum production from 55 wells was about the same as in 1962. Eight new wells totaling 47,700 feet were drilled. Marathon Southern Corp. produced regenerated lime.

Clarke.—Crude petroleum production from 12 wells decreased 3 percent; 7 new wells totaling 41,700 feet were drilled. Jackson Sand & Gravel Co. mined building sand and gravel. Five individuals collected mineral specimens.

Clay.—Alfred S. Stanford and D. O. Dablen collected mineral specimens.

Cleburne.—Leon McCluer collected mineral specimens.

Colbert.—Tri-States Limestone, Inc., Alabama Asphaltic Limestone Co. (Maloney quarry), Ralph Rogers & Co. Inc., and the Alabama State Highway Department crushed limestone for concrete and road, agricultural stone (agstone), riprap, railroad ballast, and stone sand. Alabama Asphaltic Limestone Co. (Margerum quarry) mined native asphalt for roadstone.

Conecuh.—Castleberry Gravel Co. mined building sand and building and paving gravel. Conecuh Limestone, Inc., crushed limestone for agstone.

Coosa.—T. A. Simpson, A. B. Dunning, and D. O. Dahlen collected mineral specimens.

Covington.—Miller Lime Pit crushed limestone for roadstone and agstone. B & B Sand Co. mined building sand at Andalusia.

Crenshaw.—McGhee & Merril Co. mined brown iron ore.

Cullman.—C & M Coal Co. (No. 3 mine and No. 3 strip mine) and H. E. Drummond Coal Co. (Arkadelphia No. 1 strip mine) mined bituminous coal.

Dale.—Speigner Concrete Block Co. produced building and fill sand.

Dallas.—Alabama Metallurgical Corp. operated the Selma plant and produced magnesium metal and dolomitic lime. C. Pierson Cosby mined building and engine sand and miscellaneous gravel.

De Kalb.—Pearsall Limestone, Inc., crushed limestone for riprap and agstone.

Elmore.—Alabama Gravel Co. mined building and paving sand and paving gravel. Jenkins Brick Co. mined miscellaneous clay for heavy clay products. G. H. Britt, Bill Bibb, and E. O. Dahlen collected mineral specimens.

Escambia.—Crude petroleum production from 29 oil wells decreased 10 percent; 1 new well was drilled to a depth of 12,200 feet. Dixie Sand & Gravel Co. and Flomaton Gravel Co. Inc. mined building and

paving sand and gravel. Keego Clay Products Co. mined miscellaneous clay for heavy clay products. Container Corp. of America produced regenerated lime.

Etowah.—Republic Steel Corp. produced pig iron at Gadsden. Alabama Aggregate and Birmingham Slag crushed limestone for riprap, concrete and roads, agstone, and fluxing stone. Williams Sand & Gravel Co. Inc. and Southside Sand Co. mined building, paving, and fill sand and gravel at Gadsden. R & F Sand Co. mined miscellaneous clay for heavy clay products.

Franklin.—Alabama Limestone produced dimension limestone for rubble, rough architectural stone, dressed building stone, and curbing and flagging. Clark & Ford, Inc., and Alabama Limestone crushed limestone for concrete and roads, agstone, and asphalt filler. U.S. Pipe & Foundry Co. (Russellville No. 15 mine), Shook & Fletcher Supply Co. (Blackburn mine), and Hester & Farned mined brown iron ore. Tennessee Valley Sand & Gravel Co. (Spruce Pine mine) and North Alabama Sand Co. Inc. mined building and paving sand and gravel. Tennessee Valley Sand & Gravel Co. mined fire clay for refractory use.

Geneva.—B & H Sand Co. mined building and fill sand.

Henry.—Harbison-Walker Refractories Co. and Wilson-Sneed Mining Co. mined bauxite for refractories and chemicals. Harbison-Walker Refractories Co. mined refractory kaolin. Abbyville Lime Co. crushed limestone for agstone.

Houston.—L. C. Smith Sand & Gravel Co. mined building sand at Dothan.

Jackson.—Reams & Smith Coal Co. (No. 1 mine) and W. E. Payne Coal Co. (Payne mine) mined bituminous coal. B & W Limestone Co. and Ashburn & Gray, Inc., crushed limestone for concrete and roads.

Jefferson.—Fifty-nine coal mines were active; leading mines were the Concord No. 1 mine (Tennessee Coal & Iron), the Maxine mine (Alabama By-Products Corp.), and the Mulga mine (Woodward Iron Co.).

Southern Cement Co. produced masonry and slag cement at the North Birmingham mill. Universal Atlas Cement, Lone Star Cement Corp., Lehigh Portland Cement Co., and Alpha Portland Cement Co. produced masonry and portland cements.

Tennessee Coal & Iron, Woodward Iron Co., U.S. Pipe & Foundry Co., and Republic Steel Corp. produced pig iron, and Tennessee Coal & Iron produced steel. Woodward Iron Co. operated the Pyne mine and produced red iron ore.

Dolcito Quarry Co., Tennessee Coal & Iron, Universal Atlas Cement, Lone Star Cement Corp., Lehigh Portland Cement Co., Alpha Portland Cement Co., and U.S. Pipe & Foundry Co. crushed limestone for fluxing stone, stone sand, cement, refractories, concrete and roads, agstone, asphalt filler, rock dust for coal mines, and metallurgical uses.

Lehigh Portland Cement Co., Lone Star Cement Corp., Universal Atlas Cement, Watkins Brick Co., Natco Corp., and W. S. Dickey Clay Manufacturing Co. mined miscellaneous clay for use in cement and heavy clay products. Universal Atlas Cement, Sam P. Acton, and Enos Vann crushed sandstone for refractories, foundries, and cement. Bibby Coal, Shale & Clay Co. mined a small quantity of fire clay.

T. N. Smith collected a few mineral specimens. Zonolite Co. exfoliated vermiculite from out of the State at its Birmingham plant.

Lee.—T. N. Smith and W. S. Wyatt collected mineral specimens.

Limestone.—The Limestone County Board of Revenue crushed limestone for concrete and roads.

Macon.—Birmingham Slag, Southeastern Sand & Gravel Co., Sharpe Sand & Gravel Co., and Tri-State Sand Co. mined building, paving, molding, and fill sand and building, paving, railroad ballast, fill, and other gravel.

Madison.—Madison Limestone Co. crushed limestone for concrete and roads. Alabama Brick & Tile Co. and Huntsville Brick & Tile Co. mined miscellaneous clay for heavy clay products. E. O. Dahlen collected several mineral specimens.

Marengo.—Lone Star Cement Corp. produced portland cement and crushed limestone for cement at Demopolis. Gulf States Paper Corp. produced regenerated lime.

Marion.—Thirty-six coal mines were active; leading producers were Brookside-Pratt Mining Co. (New River strip mine), Coalite, Inc. (Brilliant strip mine), and L. & M. Coal Co. (No. 1 strip mine). Thomas Alabama Kaolin Co. mined kaolin at Hackelburg. A small quantity of natural gas was produced.

Marshall.—C. A. Langford & Co. crushed limestone for concrete and roads. Brookshire & Kirkland Sandstone Co. produced crushed sandstone, which was used for filler, and a small quantity of dimension sandstone, which was used for dressed building stone.

Mobile.—Production of crude petroleum from 390 wells increased 27 percent, and 75 new wells totaling 864,000 feet were drilled. Ideal Cement Co. produced masonry and portland cements and mined miscellaneous clay for cement. Radcliff Materials, Inc., and Southern Oystershell Milling Corp. dredged oystershells from Mobile Bay for cement, roadstone, and poultry grit. Radcliff Materials, Inc., and Hicks Sand Co. mined building and paving sand and gravel. Scott Paper Co. and International Paper Co. produced regenerated lime.

Monroe.—Mannings Sand & Gravel Co. mined building sand and building and paving gravel.

Montgomery.—Birmingham Slag, Alabama Gravel Co., Montgomery County Highway Department, and Deep South Construction Co. Inc. mined building and paving sand and building, paving, and railroad ballast gravel. Jenkins Brick Co. and Excelsior Brick Co. mined miscellaneous clay for heavy clay products.

Morgan.—Trinity Stone Co., Inc., and Waters Quarries, Inc., crushed limestone for riprap, roadstone, and agstone. Decatur Sand & Gravel Co. mined building and paving sand and gravel.

Pike.—Glenwood Mining Co. Inc., Armco Mining Co., and Dunbar Mining Co. Inc. mined brown iron ore.

Randolph.—Dixie Mines, Inc., mined scrap mica at the Dixie mine.

Russell.—Bickerstaff Brick Co., Inc., Dixie Brick Co., and Bickerstaff Co. Inc. mined miscellaneous clay for heavy clay products. Consolidated Gravel Co. Inc. mined building and railroad ballast sand and building and paving gravel.

St. Clair.—National Cement Co. produced portland and masonry cement at the Ragland mill. National Cement Co. crushed limestone

for use in cement at the Ragland quarry. Ragland Brick Co. and National Cement Co. mined miscellaneous clay for heavy clay products and cement. Riverside Clay Co. (Riverside, Pell City, and McAffee mines) mined fire clay for refractories.

Shelby.—Southern Cement Co. produced masonry and portland cements at the Calera mill. Southern Cement Co., Longview Lime Corp., United Cement Co. Inc., Alabaster Lime Co., and Chaney Lime & Cement Co. produced quicklime and hydrated lime for agricultural, building, chemical, and industrial uses. Southern Cement Co., Birmingham Slag, Longview Lime Corp., Alabama Aggregate, Southern Rock Products Co. Inc., United Cement Co. Inc., Montevello Limestone Co., Alabaster Lime Co., and Chaney Lime & Cement Co. crushed limestone for roadstone, agstone, paper, cement, lime, riprap, fluxing stone, chemicals, rock dust for coal mines, asphalt filler, stone sand, and magnesium metal refining. Thirteen coal mines were active. The leading producers were Southern Electric Generating Co. (Segco No. 2 mine), Alabama Red Ash Coal Co. (No. 2 mine), and River Valley Coal Co. (River Valley No. 8 mine). Southern Cement Co. mined miscellaneous clay for cement. Shelby Sand & Ore Co. mined a small quantity of brown iron ore. T. N. Smith collected a few mineral specimens.

Sumter.—One oil well was drilled 7,700 feet deep.

Talladega.—Thompson-Weinman & Co., Moretti-Harrah Marble Co., and Georgia Marble Co. crushed marble for whiting, terrazzo, and other uses. Moretti-Harrah Marble Co. and Georgia Marble Co. quarried dimension marble for building and monumental stone. Talladega Materials Co. Inc. crushed limestone for concrete and roads. John B. Lagarde, Inc., mined building sand and gravel. American Talc Co. mined and ground talc at Winterboro for paint, insecticides, toilet preparations, and pharmaceuticals. Rucker Mining Co. mined a small quantity of brown iron ore. E. O. Dahlen collected a few mineral specimens. Kimberly-Clark Corp. produced regenerated lime.

Tallapoosa.—E. O. Dahlen, A. A. Jackson, and T. N. Smith collected mineral specimens.

Tuscaloosa.—Nine coal mines were active; leading producers were Mitchell Bros. Construction Co. (Mitchell No. 2 and No. 3 strip mines) and C. L. Abston Coal Co. Southeastern Coal & Iron Co. mined red iron ore at Dudley; during the year the company was acquired by Woodward Iron Co. Yazoo Gravel Co. Inc. and Tuscaloosa Sand & Gravel Co. mined building and paving sand and gravel. Eight collectors collected mineral specimens. Gulf States Paper Corp. produced regenerated lime.

Walker.—Forty-eight coal mines were active; leading producers were Southern Electric Generating Co. (Segco No. 1 mine), Alabama Power Co. (Gorgas mine), and Peabody Coal Corp. (Tiger strip mine). Natco Corp. mined fire clay for refractories.

Washington.—Lone Star Cement Corp. crushed limestone at the St. Stephens quarry and transported it to New Orleans for use in the manufacture of cement. Olin Mathieson Alabama Chemical Corp. recovered salt from brine at the McIntosh plant. Faith & Hayes Sand

& Gravel Co. and Mid-South Materials, Inc., mined building and paving sand and gravel.

Winston.—McCoy Coal Co. (Winston strip mine) and Summit Coal & Land Co., Inc. (Winston strip mine), mined bituminous coal. Wincala Sand & Gravel Co. Inc. mined building sand and building and miscellaneous gravel at Haleyville. W. E. Broome collected mineral specimens.

747-416—64——6

The Mineral Industry of Alaska

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Division of Mines and Minerals of the Alaska Department of Natural Resources, for collecting information on all minerals.

By Kevin Malone [1] and Phil R. Holdsworth [2]

PETROLEUM and natural gas again dominated the mineral industries in Alaska, as has been the case since the 1957 Swanson River oil discovery by Richfield Oil Corp. With the Swanson River oilfield producing at rated capacity for the full year and production of gas from the Kenai unit more than doubling, value of oil and gas rose to a record high $33.8 million, compared with $31.7 million in 1962. At yearend, the Swanson River field had 54 oil wells producing; development of the field was considered completed. Repressurizing of the Hemlock producing zone with gas from upper Swanson River strata was on a continuing basis; three wells were injecting 476,000 thousand cubic feet per month for pressure maintenance. At midyear, Standard Oil Co. of California formally opened a 20,000-barrel-per-day Kenai refinery. The $10 million plant produced heating oils and jet fuels; production of gasoline, asphalt, and other products was a future possibility.

The event of greatest significance to the petroleum industry and the State was an oil discovery in SRS Middle Ground Shoal in Cook Inlet. The discovery confirmed the favorable outlook held for the offshore Inlet formations. In a noteworthy control operation, Pan American Petroleum Corp. successfully sealed off the burning blowout in Cook Inlet. The well, Cook Inlet-State No. 1, had been blowing out-of-control since the summer of 1962; it had been ignited to avoid the hazards to navigation inherent in an unlit blowout.

Value of mineral production was at an alltime high of $67.8 million, surpassing the previous record high of $54.2 million set in 1962. Oil and gas, increasing 7 percent over figures for 1962, accounted for 50 percent of total value. Value of sand and gravel, reflecting increased production for Alaska Department of Highways projects, was $22.0 million and 32 percent of total mineral value. Coal, with both tonnage and value decreasing somewhat from 1962 figures, dropped from second to third rank. Output of gold decreased to 99,573 ounces ($3.5 million), the smallest physical quantity produced since 1894, the World War II years excepted. Shutdown of one of the large dredging operations on the Seward Peninsula at the close of the 1962 dredging season was a significant factor in the decrease. Production of mercury slumped to 400 flasks, the lowest output since 1955.

[1] Physical scientist, Bureau of Mines, Juneau, Alaska.
[2] Commissioner, Department of Natural Resources, State of Alaska, Juneau, Alaska.

TABLE 1.—Mineral production in Alaska [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Coal (bituminous)—thousand short tons	871	$6,409	853	$5,910
Gold (recoverable content of ores, etc.)—troy ounces	165,259	5,784	99,573	3,485
Lead (recoverable content of ores, etc.)—short tons			5	1
Mercury—76-pound flasks	3,719	711	400	76
Natural gas—million cubic feet	2,184	467	4,498	1,111
Petroleum (crude)—thousand 42-gallon barrels	[2] 10,259	[2] 31,187	[3] 10,740	[3] 32,650
Sand and gravel—thousand short tons	5,731	5,355	16,926	22,005
Silver (recoverable content of ores, etc.) thousand troy ounces	22	24	14	18
Value of items that cannot be disclosed: Gem stones, peat (1962), platinum-group metals, stone, and uranium ore		[2] 4,255		2,584
Total		[2] 54,192		67,840

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Revised figure.
[3] Preliminary figure.

In table 2, a constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Exploration expenditures for metals and nonmetals increased 15 percent. Estimates for mineral exploration (excluding oil and gas) by the Alaska Division of Mines and Minerals were $1.5 million compared with $1.3 million in 1962. In southeastern Alaska, copper,

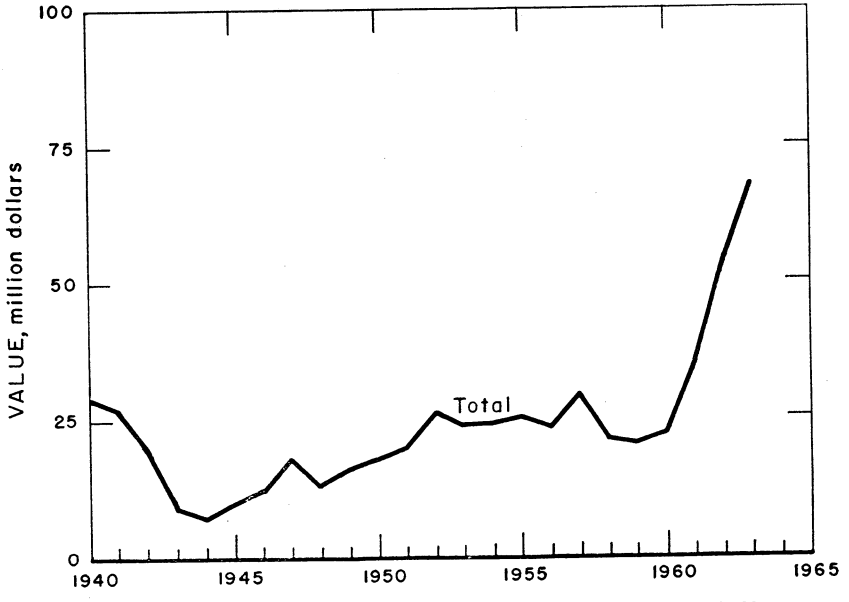


FIGURE 1.—Total value of mineral production in Alaska, 1940–63.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$28,473	1958	$21,642
1953	24,535	1959	20,644
1954	25,551	1960	22,198
1955	25,940	1961	34,963
1956	23,487	1962	53,482
1957	28,596	1963	66,793

TABLE 3.—Expenditures by major companies for exploration and prospecting

(Thousand dollars)

Type and region	1962	1963
Metals exploration:		
Southeastern Alaska	$350	$120
Copper River and Prince William Sound		70
Kuskokwim River and Yukon River	260	200
Northwestern Alaska	500	720
Other	190	390
Total metals	1,300	1,500
Oil and gas:		
Exploration	46,712	54,030
Development drilling	[1] 18,788	4,635
Production		1,594
Refinery construction and maintenance		5,600
Total oil and gas	65,500	65,859
Grand total	66,800	67,359

[1] Includes development drilling, production costs, and refinery construction and maintenance costs.

Source: Division of Mines and Minerals, Department of Natural Resources, Alaska.

nickel, iron, uranium, beryllium, and gold deposits were examined or explored. In central Alaska work was done on limestone deposits, nickel-copper, copper-molybdenum, silver-lead, mercury, and gold deposits. To the northwest, offshore gold placer deposits at Nome and Bluff were prospected and exploration continued at the Ruby Creek copper deposit near Kobuk. Beryllium deposits in the Lost River area of the Seward Peninsula were under study.

Employment.—Activity at 253 mining and milling operations furnished employment for 2,145 men including 90 men employed in assessment work, prospecting or exploration and development. In addition, the oil industry employed 737 men in exploration and production.

Injuries.—There were no fatalities chargeable to the mineral industries. Lost-time accidents were 75 compared with 95 in 1962. Of the lost-time accidents recorded, 30 occurred at coal mining operations. Coal mines worked 48,640 man-days, compared with 246,607 man-days worked by other sections of the minerals industry. One fatality was recorded to the oil industry; lost-time accidents were 101.

Wages and Hours.—Mines in Alaska operated an average of 138 days. This low figure for days operated resulted from the seasonal nature of many mining operations and the number of men employed in prospecting and assessment work.

For the mineral industries covered by the Employment Security Act (operators with hired labor), monthly earnings averaged $873. Monthly earnings in metal mining were $702, in nonmetals $897, in

coal mining $946, and in oil and gas (production and exploration) $911. The figures for 1962 were $842, $677, $1,000, $917, and $889, respectively.

Legislation and Government Program.—Studies by the U.S. Army Corps of Engineers and other Government agencies on the proposed Rampart hydroelectric development on the Yukon River continued in 1963. In August, the Alaska District Engineer for the Corps submitted an engineering report to the division engineer in Portland, Oreg. Still in process at that time were a market report, an impact report, and a report from the Fish and Wildlife Service. Army engineers released a tentative schedule for the project—if and when it is approved. Based on a schedule of appropriations of $60 million per year over the first 14 years, project planning would be done in the first 2 years, design in the 2d to 4th year, and river diversion in the 4th to 8th year. Dam construction would occur in the 4th to 15th year, and early powerhouse construction in the 5th to 13th years. The first power would be generated in the 12th year and full capacity could be attained in the 20th year.

TABLE 4.—Number of establishments in the mineral industries in 1963, classified by number of employees

Type of operation	Number of establishments employing—			
	1-9	10-19	20-29	30 and over [1]
Coal mines	1		1	3
Metal mines [2]	145	5	1	3
Quarries and mills	2	1		2
Sand and gravel operations	6	82	1	
Total	154	88	3	8

[1] Includes 2 operations employing 30-39 men; 3 operations 40-49 men; 1 operation 50-59 men; and 2 operations 60-69 men.
[2] Includes assessment, exploration, and development operations.

TABLE 5.—Employment and injuries in the mineral industries

Year and industry	Active operations	Men working daily	Average active days	Man-hours worked	Nonfatal injuries	Injuries per million man-hours
1962: [1]						
Coal mines	6	186	293	437,354	37	85
Quarries and mills	6	225	99	178,591	4	22
Metal mines	126	496	163	700,014	42	60
Sand and gravel mines	37	716	91	581,665	12	21
Total	175	1,623	137	1,897,624	95	50
1963: [2]						
Coal mines	5	185	263	391,394	30	77
Quarries and mills	5	117	128	120,408	2	17
Metal mines	154	505	138	619,006	13	21
Sand and gravel mines	89	1,338	121	1,458,034	30	21
Total	253	2,145	138	2,588,842	75	29

[1] Figures subject to revision.
[2] Preliminary figures.

In a related action, the Board of Army Engineers for Rivers and Harbors rejected a series of proposed navigation and flood control projects on the Yukon and Kuskokwim Rivers. The Board concurred

in a report from the Alaska district engineer finding no navigation or flood control projects economically justified, but noting that the projects studied might become justified in the future as the development of the area continued.

Following through on its 1962 decision to defer further activity on Project Chariot, the proposal to construct a harbor at Cape Thompson on the Chukchi Sea using nuclear explosives, the U.S. Atomic Energy Commission (AEC) recalled its application for withdrawal of some 1.1 million acres. The Commission announced that its Cape Thompson research station was to be turned over to the Navy's Arctic Research Laboratory at Point Barrow for use as a small satellite field station. AEC retained approximately 150 parcels of land within the area which were to be developed into study plots, campsites, and service areas. The Commission stressed again that the action was a deferral and that no final decision on Chariot had been made. Opposition to the nuclear blast, largely from Eskimos and Indians of northwestern Alaska who feared radioactive contamination of reindeer and caribou herds, was a factor in the AEC decision.

Office of Minerals Exploration (OME) approved an exploration contract with Keystone Mines, Inc., Fairbanks, for work on a group of small lode gold properties in the Fairbanks mining district. The total estimated cost of the work was $79,900, of which the Government was to furnish 50 percent with the provision that the money be repaid from royalties on any ore found by the exploration. Exploration of gold lodes in the Chandalar district, north of the Arctic Circle, by Little Squaw Mining Co. of Spokane, Wash., continued. Work accomplished included improvements to roads and the airstrip, surface trenching by bulldozer to expose veins, and underground drifting and crosscutting. In 1962 OME had executed an exploration contract with Little Squaw calling for work totaling $168,000. At Van Curlers Bar on the Chena River 80 miles east of Fairbanks, a gold placer deposit was being explored under an OME contract. In the Kuskokwim River region, Alaska Mines & Minerals, Inc., completed exploration started in 1962 at its mercury mine in the Aniak district. The work, done under a $324,000 (total value) OME contract, apparently was not successful; the mine was closed in August and allowed to fill up with water. In other Government aid to mining, the Small Business Administration granted a $40,000 participating loan to Flat Creek Placers for use in gold placering operations in the Iditarod district.

At the State level, legislation of interest to mining people included the Prospector Assistance Program (PAP) enacted in the spring. The program provided for financial assistance to qualified prospectors with reimbursement for up to 75 percent of expenses incurred for certain items, including transportation, on approved prospecting ventures. Maximum yearly payment to any one prospector was $2,000. Reimbursement was made only after the prospecting was finished and maps and reports were submitted to the Alaska Division of Mines and Minerals. During the 1963 season, participating prospectors were active in widely scattered sections of the State from Wrangell in southeastern Alaska north to the Brooks Range and from Denali west to Lost River on the Seward Peninsula and to Hooper Bay.

Transportation.—Inauguration of ferry service between Prince Rupert, British Columbia, and southeastern Alaska ports, and develop-

TABLE 6.—Coastwise receipts and foreing mineral trade

Commodity	1961			1962		
	Coastwise receipts	Imports	Exports	Coastwise receipts	Imports	Exports
Anthracite, bituminous coal and lignite, coal and coke briquettes, and coke—short tons	894	10	-------	623	20	-------
Motor fuel and gasoline—thousand barrels	2,463	-------	(1)	2,444	-------	1
Gas, oil, distillate, and residual fuel oil—do	4,530	-------	(1)	5,722	33	1
Petroleum asphalt—short tons	7,103	-------	-------	18,388	-------	-------
Lubricating oil and greases—thousand barrels	57	(1)	(1)	68	42	-------
Petroleum products, not elsewhere classified—do	117	-------	-------	70	-------	-------
Building cement—376-pound barrels	318,705	39,810	-------	168,064	18,014	-------
Building, monument, and other stone manufacturers, not elsewhere classified—short tons	5,679	-------	-------	6,300	-------	-------
Clays and earths—do	4,011	-------	-------	6,411	107	-------
Brick and tile—do	1,908	-------	-------	1,165	-------	-------
Sulfur—do	-------	4,143	-------	-------	6,854	-------
Sand, gravel, and crushed rock, including limestone—short tons	44,005	-------	-------	172,250	-------	-------
Iron ores and concentrates—do	164	-------	-------	94	-------	-------
Iron and steel scrap—do	1,804	-------	8,130	5	2	-------
Iron and steel products—do	28,412	1,549	-------	16,804	6,170	-------
Aluminum metal and alloys in crude and semifabricated forms—short tons	291	-------	-------	194	-------	-------
Copper semifabricated forms—do	475	-------	-------	323	-------	-------
Lead and lead-base alloys in crude and semifabricated forms—short tons	26	-------	-------	10	-------	-------
Other nonferrous ores, concentrates, metals and scrap, except precious, in crude and semifabricated forms—short tons	100	-------	30	1,181	-------	25,718
Fertilizer materials—do	4,332	1,185	-------	2,483	3,043	-------

1 Less than 500 barrels.

Source: Waterborne Commerce of the United States, Part 4, Pacific Coast, Alaska, and Pacific Islands, calendar years 1961–62, by the U.S. Army Corps of Engineers.

ments in railcar shipment via sea from Prince Rupert and Seattle to Port Whittier, featured the news in transportation.

The first of three State ferries for service between Skagway and Prince Rupert was put into operation in January; by midyear the three ferry system was in operation. The new system provided passenger, auto, and roll-on roll-off freight service over the 450 mile route between Prince Rupert and Alaska port cities along the Inside Passage. Traffic over the system in 1963 was well above that estimated in feasibility studies made for the State. As the year drew to a close, plans to link Vancouver and Victoria, British Columbia with Prince Rupert and thence with southeastern Alaska port cities, were under discussion between Alaska and British Columbia officials. Initial discussions looked to ferry service between Port Hardy, on the northern tip of Vancouver Island, and Prince Rupert starting by summer of 1965.

Canadian National Railways added a second railcar barge to the one put into service in 1962 between Prince Rupert and Port Whittier, 50 miles southeast of Anchorage on the Alaska Railroad. The additional barge allowed weekly service between the two points. The Canadian carrier also began car barge service between Prince Rupert and Saxman, just south of Ketchikan.

Puget Sound-Alaska Van Lines instituted railcar service between Seattle and Whittier with the launching of the "hydro-train" barge CLAIR ENGLE at midyear. The 304-foot barge, built in Portland, Oreg., was capable of hauling 30 railcars. In December, the 342-foot KENAI, with a capacity of 42 cars, was launched for service on the same run. Puget Sound-Alaska Van Lines officials estimated econ-

omies resulting from the car-barge service could cut some freight costs as much as 40 percent.

The Federal Maritime Commission, contrary to the recommendations of its examiner in the case, approved the 10 percent water freight rate increase allowed on a conditional basis in January 1960. The Commission allowed Alaska Steamship Co., the increased rates, but ordered further hearings on rate proposals by Puget Sound-Alaska

TABLE 7.—Freight rates, Seattle to selected Alaskan cities 1963 Hydro-Train service [1]

(Cents per hundred pounds)

Commodity	Seattle to—		
	Anchorage via Whittier	Fairbanks via Whittier	Seaward via Whittier
Groceries 60,000-pound minimum	218	277	213
Do. 80,000-pound minimum	183	242	178
Do. 100,000-pound minimum	173	232	168
Iron or steel articles 60,000-pound minimum	230	290	220
Do. 80,000-pound minimum	178	219	172
Do. 100,000-pound minimum	168	209	162
Machinery 60,000-pound minimum	247	290	233
Do. 80,000-pound minimum	212	255	198
Do. 100,000-pound minimum	202	245	188
Lumber 60,000-pound minimum	206	254	207
Do. 80,000-pound minimum	171	219	172
Do. 100,000-pound minimum	161	209	162
Ores and concentrates (southbound only) [2] 60,000-pound minimum	109	145	----------
Do. 80,000-pound minimum	92	128	----------
Do. 100,000-pound minimum	87	123	----------
Petroleum and products 60,000-pound minimum	210	308	210
Do. 80,000-pound minimum	175	273	175
Do. 100,000-pound minimum	165	263	165

[1] Rates include all-risk insurance.
[2] Value not to exceed $60 per ton. Rate increases 25 percent for each additional $60 (or fraction) per ton valuation.

Source: Puget Sound-Alaska Van Lines.

Van Lines; Garrison Fast Freight, Division of Consolidated Freightways Corp.; and Alaska Freight Lines, Inc. The Commission found, in the case of the latter three, that the record was not sufficient to reach any conclusions as to the justness and reasonableness of the rate increases applied for. No conclusions were reached with regard to the application of Coastwise Line because that firm withdrew from Alaska service during the Commission's proceedings.

In road construction, the Alaska Department of Highways had 74 active construction contracts in force during 1963 with a contract price in excess of $73 million. Contracts completed in 1963 totaled $18.7 million and 247.5 miles; carryover was $54.8 million and 473 miles. Total project value of the highway program, with construction engineering included, was $84 million. In 1962 the department had $36 million of work underway; the 1961 figure was $15 million. Of the 247.5 miles of road completed, 97.3 miles were primary, 86.5 miles secondary, 63.1 miles pioneer access roads, and 0.6 mile miscellaneous approaches. In the Fairbanks district 25 miles, primary, were constructed from Ester to 25 miles west; 28 miles, primary, linked Nenana and Rex. Other primary roads included Alaska Railroad to Sunshine, Tolsona Creek to Glennallen Junction, and Tanana River to Delta

Junction. Completed secondary road projects included 13.4 miles from Bluestone to Teller and 13.8 miles from Penny River to Sinuk River on the Nome-Teller Road, and 9.9 miles from Coffee Creek to Kougarok River, all on the Seward Peninsula. Pioneer access roads were built at Chandalar Lake, Eureka-Rampart, Teller-Lost River, and Chitina-McCarthy. Secondary bridges were completed over Cripple River (Nome-Teller) and Liberty Creek (Copper River Highway).

By an executive order signed by President Kennedy, rates established by The Alaska Railroad (operated for the Federal Government by the Department of the Interior) were made subject to the approval of the Interstate Commerce Commission.

The Congress authorized and appropriated $400,000 for a comprehensive highway study to develop an integrated system of primary and secondary highways in Alaska. The Department of Commerce, coordinating the project, selected Transportation Consultants, Inc., and Wilbur Smith and Associates to make the study.

Late in the year Wien Alaska Airlines took over the Juneau-Whitehorse-Fairbanks route flown by Pan American Airways for 28 years. Wien Alaska omitted the Whitehorse stop at the start of the new service pending clearance of regulations with Canadian air authorities. Wien was using Fairchild F27 prop jets on the Fairbanks run; Pan American had been using DC–6B's.

Water.—As a part of its broad mission to conserve and develop the Nation's mineral resources, the Bureau of Mines canvasses the mineral producers in 1963 for water usage in 1962. The following four tables summarize the results of the canvass for the year 1962.

TABLE 8.—Water use ratios per ton of crude material, 1962

(Gallons per ton of crude material)

Commodity	New water ratio	Discharged water ratio	Recirculated water ratio	Consumed water ratio
Bituminous coal	2,107	2,102	207	5
Mercury ores	106	106	----	----
Placer gold	967	967	196	----
Uranium ores	160	160	----	----
Other metallic minerals	1,511	1,420	----	91
Sand and gravel	125	70	88	55

TABLE 9.—Water use by commodities, 1962

(Million gallons)

Commodity	New water	Water recirculated	Total water use	Water discharged	Water consumed
Bituminous coal	1,344	132	1,476	1,340	4
Metal mines and mills	16,286	2,722	19,008	16,115	170
Sand and gravel mines	715	505	1,220	401	314
Total	18,345	3,359	21,704	17,856	488

TABLE 10.—Water use by region, 1962 [1]

(Million gallons)

Region	New water	Recirculated water	Total water	Discharged water	Consumed water
Aleutian Islands	3	2	5	2	1
Cook Inlet-Susitna	159	170	329	132	27
Kodiak	1	----	1	1	----
Kuskokwim River	3,852	----	3,852	3,683	169
Northwestern Alaska	75	----	75	75	----
Seward Peninsula	1,569	1,633	3,202	1,569	----
Southeastern Alaska	10	3	13	8	2
Yukon River	12,032	1,096	13,128	12,026	6
Undistributed	643	455	1,098	360	283
Total	18,344	3,359	21,703	17,856	488

[1] Petroleum and natural gas not included.

TABLE 11.—Water use in petroleum drilling in 1962, by regions [1]

Region	Number of wells	Total footage	Fresh water used (42-gallon barrels)	Saline water used (42-gallon barrels)	Total barrels per foot
Alaska Peninsula	1	1,215	5,000	----	4.12
Cook Inlet-Susitna	15	131,485	404,000	57,000	3.51
Copper River	4	32,397	96,000	----	2.96
Kenai Peninsula	19	183,229	662,000	----	3.61
Southeastern Alaska	2	15,625	10,000	----	.64
Yukon River	1	3,062	9,000	----	2.94
Total	42	367,013	1,186,000	57,000	3.39

[1] All drilling in Alaska with rotary tools.

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—Exploration and development on the Stampede mine, northeast of Kantishna, Yukon River region, was accomplished in 1963. The operator reported stockpiling 210 tons of stibnite ore for later treatment.

Beryllium.—Interest in the beryllium resources of Alaska continued to be strong. On the Seward Peninsula, Newmont Exploration, Ltd., had two diamond drills active exploring deposits in the Rapid River-Lost River area owned by Pankratz & Brown. United States Smelting Refining & Mining Co. was also active in the same area, as were Grothe & Pearce. Under the State's Prospectors Assistance Program, four men prospected Lost River-Rapid River and environs and staked several claims. Additional reconnaissance was done on the beryllium showings near Bokan Mountain, Prince of Wales Island, southeastern Alaska region.

Copper.—Examination and exploration of deposits in southeastern Alaska, Copper River, and northwestern Alaska regions continued. Japanese companies were reported as negotiating for a copper deposit in the Maclaren River in the Cook Inlet-Susitna region.

Gold.—Output of gold in Alaska declined to 99,573 ounces, the lowest physical quantity recorded since 1894, except for 1944 and 1945 when gold mining was severely restricted under wartime regulations. Value of production, at less than $3.5 million, was the lowest recorded since 1898, the year of the Nome discoveries, again excepting 1944 and 1945.

TABLE 12.—Mine production of gold, silver, and other metals,[1] in terms of recoverable metals[2]

Year	Mines producing		Material sold or treated[3] (short tons)	Gold (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)
1954–58 (average)	4	121	7,115	221,801	$7,763
1959	2	94	617	178,918	6,262
1960	6	92	234	168,197	5,887
1961	8	86	645	114,216	3,998
1962	1	66	162	165,259	5,784
1963	4	72	914	99,573	3,485

Year	Silver (lode and placer)		Other		Total value (thousands)
	Troy ounces	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	29,624	$27	5	$2	$7,792
1959	21,358	19	36	22	6,303
1960	25,934	23	64	32	5,942
1961	18,485	17	116	60	4,075
1962	22,199	24	----	----	5,808
1963	14,010	18	5	1	3,504

[1] Includes copper, lead and zinc produced.
[2] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes retreated, and ore shipped to smelters during calendar year indicated.
[3] Does not include gravel washed.

TABLE 13.—Fifteen leading gold-producing mines in 1963, in order of output

Rank in 1963	Rank in 1962	Mine	District	Region	Operator	Source of gold
1	1	Fairbanks Unit	Fairbanks	Yukon River	United States Smelting Refining & Mining Co.	Dredge (2).
2	3	Hogatza River	Hughes	do	do	Dredge (1).
3	4	Chicken Creek	Fortymile	do	do	Do.
4	5	Nyac	Aniak	Kuskokwim River.	New York-Alaska Gold Dredging Corp.	Do.
5	6	Woodchopper Creek.	Circle	Yukon River	Mathews Mining Co	Do.
6	8	Prince Creek	Iditarod	do	Prince Creek Mining Co.	Nonfloat.
7	10	Kougarok River	Kougarok	Seward Peninsula.	Martinson Brothers	Dredge (1).
8	13	Flat Creek	Iditarod	Yukon River	Flat Creek Placers	Nonfloat.
9	7	Otter Creek	do	do	Otter Dredging Co	Dredge (1).
10	12	Ready Bullion Creek.	Fairbanks	do	Hassel Mining Co	Hydraulic.
11	(1)	Moore Creek	Kantishna	do	Stuver & Magnuson	Nonfloat.
12	(1)	Candle Creek	Fairhaven	Seward Peninsula.	Avon Enterprises, Inc	Do.
13	(1)	Yankee Creek	Innoko	Yukon River	Toivo Rosander	Do.
14	(1)	Taylor Creek	Kougarok	Seward Peninsula.	N. B. Tweet & Sons	Dredge (1).
15	15	Solomon River	Nome	do	Lee Bros. Dredging Co	Do.

[1] Not among the 15 highest in 1962.

United States Smelting Refining & Mining Co. (U.S.S.R. & M.) operated dredges in the Fairbanks district, at Hogatza River in the Hughes district, and at Chicken Creek in the Fortymile district. The company was reported to have a remnant of thawed ground on Cripple Creek in the Fairbanks district that was to be dredged in the 1964 season. With completion of the Cripple Creek work in 1964, the U.S.S.R. & M. dredging operations in the major fields at Fairbanks were expected to be finished. The Fairbanks fields had been the leading gold producer in Alaska since 1946. U.S.S.R. & M. dredging operations at Chicken Creek and Hogatza River were scheduled to run to 1966 or 1967. The Hogatza River operation, in naturally thawed ground, was a possibility to run beyond 1967.

Other important dredging operations were at Nyac, Kuskokwim River region, by New York-Alaska Gold Dredging Corp.; at Circle, Yukon River region, by Mathews Mining Co.; in the Kougarok, Seward Peninsula region, by Martinson Bros.; and at Flat, Yukon River region by Otter Dredging Co.

Interest in the mineral potential of the State's offshore placers, particularly in the Nome area, continued. Individuals and small groups were active in exploration off the coast of Nome. Shell Oil Co. was granted an extension of time on its offshore prospecting permits; at yearend the company was preparing to resume drilling and other exploratory work through the ice of Norton Sound. Some exploration was done on offshore prospecting permits in the vicinity of Bluff. In southeastern Alaska there was no report of activity on offshore prospecting permits granted in 1962. Preliminary work was done, however, on permits granted in 1963, and at least one permit-holder planned to explore his holdings in the 1964 season.

The Office of Minerals Exploration (OME) approved an exploration contract with Keystone Mines, Inc., Fairbanks, for work on a group of small gold lode properties in the Cleary Creek drainage of the Fairbanks district. Shaft sinking and drifting at a total estimated cost of $79,900 got underway in the fall. Under the OME regulations, the Federal Government participated in 50 percent of exploration costs with the provision that the Government be repaid from royalties on any ore found by the exploration work. While arranging for the OME loan and preparing for the shaft sinking, Keystone did considerable surface prospecting on the Homestake and the Kawalita claims. Ore uncovered in the surface work was milled at the 10-stamp Hi Yu mill on Moose Creek.

In the Chandalar district, north of the Arctic Circle, Little Squaw Mining Co. continued exploration of the camp's high-grade gold lodes. The company accomplished surface trenching and underground drifting on various claims in the district, as well as airfield construction and roadwork from the airport to the camp. Federal Resources Corp. of Salt Lake City, Utah entered into an agreement with Grandview Mines of Spokane, Wash. to participate in the Chandalar work. Little Squaw Mining Co. was a subsidiary of Grandview Mines.

TABLE 14.—Gold produced at placer mines, by methods of recovery

Method and year	Mines producing [1]	Material treated (thousand cubic yards)	Gold recovered		
			Troy ounces	Value	Average value per cubic yard
Bucketline dredging:					
1954–58 (average)	12	13,129	175,895	$6,156,318	$0.469
1959	13	12,478	146,886	5,141,010	.412
1960	15	12,988	138,620	4,851,700	.374
1961	16	10,315	94,488	3,307,080	.320
1962	16	8,061	147,766	5,171,810	.642
1963	15	5,614	83,994	2,939,790	.524
Nonfloating washing plants:					
1954–58 (average)	80	2,570	43,062	1,507,177	.586
1959	64	1,578	30,307	1,060,745	.672
1960	60	1,229	26,602	931,070	.758
1961	57	773	16,209	567,315	.734
1962	37	741	14,942	522,970	.705
1963	46	620	12,537	438,795	.708
Hydraulicking:					
1954–58 (average)	12	66	959	33,572	.515
1959	8	25	522	18,270	.729
1960	11	43	1,447	50,645	1.178
1961	10	39	2,673	93,555	2.378
1962	7	41	2,194	76,790	1.861
1963	4	17	1,049	36,715	2.146
Small-scale hand:					
1954–58 (average)	16	24	741	25,928	1.083
1959	9	11	585	20,475	1.895
1960	6	1	153	5,355	5.366
1961	3	1	87	3,045	2.643
1962	6	3	64	2,240	.844
1963	6	13	624	21,840	1.720
Underground placers (drift):					
1954–58 (average)	1	[2]	11	392	3.267
1959–62					
1963	1	[2]	158	5,530	6.913
Grand total placers:					
1954–58 (average)	121	15,790	220,668	7,723,387	.489
1959	94	14,092	178,300	6,240,500	.443
1960	92	14,261	166,822	5,838,770	.409
1961	86	11,128	113,457	3,970,995	.357
1962	66	8,846	164,966	5,773,810	.653
1963	72	6,264	98,362	3,442,670	.550

[1] Excludes itinerant prospectors, "snipers," "highgraders," and others, who gave no evidence of legal right to property.
[2] Less than 500 cubic yards.

Interest in lode gold mining, spurred perhaps by the continuing drain on the Nation's gold stocks, increased appreciably over that of recent years but was not of any real significance in the mineral resources area. Besides the OME work noted above, examinations or exploration were done on gold lodes in southeastern Alaska (Juneau and Ketchikan districts), at Willow Creek (Cook Inlet-Susitna region), at Port Wells (Prince William Sound), in the Fairbanks district, and on the Seward Peninsula. Two small mills were reported installed in the Willow Creek district.

Iron Ore.—Exploration on the iron deposits of the State continued. In southeastern Alaska, Utah Construction & Mining Co. did some work on the Kasaan Peninsula deposits, Prince of Wales Island. Deposits at Union Bay on the Cleveland Peninsula, Port Snettisham, and Klukwan also received attention. In the Yukon River region, the hematitic redbeds on the Tatonduk River north of Eagle were examined by one of the large companies. Arrangements to patent holdings on the Klukwan deposits by Klukwan Iron Ore Corp. continued through the year. The Klukwan holdings, enormous in both lode and

residual placer reserves, are low-grade titaniferous deposits that had been under study by Columbia Iron Mining Co., a United States Steel Corp. subsidiary, for a number of years. Upon completion of the study, Columbia Iron (merged into United States Steel Corp. late in the year) had leased the property for 75 years. A spokesman for Klukwan Iron said he knew of no plans to operate the deposits in the near future. Eventual exploitation of the placer section of Klukwan was envisioned with the relatively low grade sands upgraded to a plus 60-percent concentrate for shipment to Japan. Dredging was seen as a feasible method of mining and concentrating the material.

TABLE 15.—Mercury production

Year	Number of producing mines	76-pound flasks	Value [1]	Year	Number of producing mines	76-pound flasks	Value [1]
1954–58 (average)	2	2,642	$652,795	1961	2	4,129	$815,932
1959	2	3,743	851,458	1962	2	3,719	711,110
1960	3	4,459	939,779	1963	2	400	75,780

[1] Value calculated at average New York price.

Mercury.—Mercury production in Alaska dropped off sharply as a result of the closing of the Red Devil mine, Kuskokwim River region, in August. Output, almost all of it produced in the early months of the year, was less than 11 percent of that of 1962. George H. Willis, operating the Alice and Bessie mine (formerly the Parks), also in the Kuskokwim River region, was the only other producer of record. Alaska had been the third ranking State in mercury output, with approximately 13 percent of the Nation's production. The Bureau of Mines finished examination of the White Mountain deposits, 60 miles southeast of McGrath in the Kuskokwim region.

Nickel.—Exploration and examination of deposits in various parts of the State were continued in 1963. In southeastern Alaska, diamond drilling of the Brady Glacier deposit continued; further test work was done on the Funter Bay deposits on Admiralty Island. Some work was done at the Spirit Mountain deposit, near Chitina in the Copper River region and at Rainbow Mountain, near McCallum, Yukon River region. There was no Japanese survey party touring Alaska's nickel or other mineral deposits in 1963; at least one company planned to send a party to Alaska in 1964, however, with the chief interest being nickel and copper-iron deposits.

Platinum-Group Metals.—As had been the case for a number of years, Goodnews Bay Mining Co. was again the only producer of platinum as a primary product in the Nation. The company continued its dredging operations on the placers of the Salmon River in the extreme southwestern part of the Kuskokwim River region. Physical volume of platinum-group metals and value of products was maintained at approximately the rates of recent years. The company did not release any figures of operations. Fremont Mining Co. returned to the Goodnews Bay area for further geophysical and other test work on the offshore placer deposits. The company had started exploration at Goodnews Bay in the 1962 field season. No reports of results were released.

Scrap Metals.—Small quantities of ferrous and nonferrous scrap were shipped from the State. Ferrous scrap was shipped to Japan through the Port of Anchorage. The nonferrous scrap, from various points in Alaska, was shipped to Seattle.

Silver.—Output of silver, following that of gold, decreased to 14,000 ounces from the 22,000 ounces produced in 1962. Alaska silver production was largely a byproduct of gold production. With the increases in silver prices that took place in 1963, some stirrings of interest in lode deposits in the Kantishna and Hyder districts were seen. There was a small production of lode silver from the Fairbanks district.

Uranium.—The Ross-Adams deposit on Bokan Mountain, Prince of Wales Island, southeastern Alaska region, produced its quota of uranium as in past years. The operators did not grant a release to publish tonnage and grade of shipments.

MINERAL FUELS

Coal (Bituminous).—Coal dropped from second to third rank in value among the mineral commodities of the State; both tonnage and value were less than those in 1962. Again, the U.S. Armed Forces were the chief consumers of Alaska coals. Military contracts for the fiscal year 1964 totaled 652,884 tons, compared with 579,120 tons for fiscal year 1963. Usibelli Coal Mine, Inc., a strip mine operator in the Nenana (Healy River) field, was again the leading contractor with 378,522 tons. Arctic Coal Co., also operating in the Nenana field, contracted for 20,000 tons. In the Matanuska field, Evan Jones Coal Co. received a contract for 180,000 tons, and Mrak Coal Co., one for 74,362 tons.

TABLE 16.—Coal production by major fields

(Thousand short tons and thousand dollars)

Year	Matanuska		Nenana		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1955	258	$3,055	381	$2,690	639	$5,745
1956	269	3,273	457	3,055	726	6,328
1957	237	2,947	604	4,337	841	7,284
1958	290	3,532	468	3,392	758	6,924
1959	251	2,977	409	2,892	660	5,869
1960	300	3,434	422	2,884	722	6,318
1961	226	2,443	511	3,425	737	5,868
1962	309	2,871	562	3,538	871	6,409
1963	293	2,378	560	3,532	853	5,910

With the exception of minor quantities from small fields, all Alaska coal was stripmined from the Nenana and Matanuska fields. Thus the shift from underground to strip coal, the beginnings of which first appeared in the 1940's, was completed. In 1948, of 408,000 tons of coal produced, 267,000 or 65 percent was underground coal. Even as late as 1955, Alaska's underground mines were able to mine 37 percent of the State's coal production.

An estimated 77 percent of coal sold was used for heat and power at Fort Wainwright and Eielson Air Force Base near Fairbanks, at

Fort Richardson and Elmendorf Air Force Base near Anchorage, at Clear Missile Tracking Station near Nenana, and at other military installations in Alaska. Additional quantities were sold to local utility companies for heat and power and to consumers for heating and cooking. The average unit value of all coal produced was $6.93 per ton, compared with $7.35 per ton in 1962. Unit value of Alaska coals rose steadily in the early postwar years, peaking at $9.81 in 1953 under the influence of the Korean conflict. There was a period of backing and filling from 1953 to 1958; the 1958 value was $9.13 per ton. Since 1958 the trend in unit value, affected by the shift to all strip coal and by competition introduced by the marketing of natural gas from the Kenai Peninsula in the Anchorage area, has been downward. At the $6.93 per ton value for 1963, Alaska coals were almost back to the 1948 value of $6.84 per ton.

Three strip operations produced coal in the Matanuska field and two in the Nenana field. Of total coal output, the Nenana field accounted for 66 percent, the Matanuska field 34 percent. The 1962 figures were 64 percent and 36 percent, respectively. Of total tonnage mined, 44 percent was cleaned, compared with 43 percent in 1962.

Interest in the Beluga River coalfield continued in 1963. Columbia Iron Mining Co. had an exploration crew active continuing the underground work started in 1962; the chief interest seemed to be in obtaining unweathered samples of Beluga coals. The Utah Development unit of Utah Construction & Mining Co. again had an exploration crew at Beluga River. The company added two State leases to the three it acquired in September of 1962.

In the Healy River field, Vitro Minerals Corp., a 50–50 joint venture between Vitro Corp. of America and Rochester & Pittsburgh Coal Co., took over the coal mine formerly operated by Cripple Creek Coal Co. The mine, covering about 1,360 acres, had been idle for 2 years. Vitro planned to reopen the mine to supply both the civilian and military markets, and to use it as a base for mineral exploration in Alaska.

Investigations of the coalbeds in northwestern Alaska in the vicinity of Point Lay and along the Kukpowruk River were continued by private interests and by the Bureau of Mines. Union Carbide Ore Co. prospected along the Kukpowruk about 35 miles south of Point Lay and shipped samples of the coals to Japan for coking tests. The Bureau of Mines continued reconnaissance of these Arctic coals and obtained channel samples and auger borings for coking tests. Initial results obtained at the Bureau's Denver Coal Research Laboratory indicated that the coals, unblended, will not give a suitable metallurgical grade coke. Satisfactory metallurgical coke was made, however, by blending the Kukpowruk coals with various United States coking coals. In one test a blend of 85 percent Kukpowruk coal with 7.5 percent each of coking coals from Colorado and West Virginia produced coke comparable to that used at the Kaiser Steel Co.'s Fontana, California plant. The Bureau planned to extend its investigations to the Kokolik River area in the 1964 season. A report of investigations on these Arctic coals was in process.

Petroleum and Natural Gas.—Discovery of a new oilfield in the middle of Cook Inlet, Alaska's third oil find, was the most significant event of the year for the petroleum industry. Shell Oil Co., as operator

for a three-member group including Richfield Oil Corp., and Standard Oil Co. of California, made the discovery in SRS Middle Ground Shoal No. 1, almost in the center of Cook Inlet and 22 miles west of the Swanson River field. SRS Middle Ground Shoal No. 1 flowed at a rate of 700 barrels per day of 35.5°-gravity crude from a total of 550 feet of oil sands between 7,480 and 8,177 feet. The well was drilled in 125 feet of water from the floating drill ship, the CUSS II. Shell termed the well a "major discovery" of oil. SRS Middle Ground Shoal No. 1 is 3 miles south of the Pan American Petroleum Corp. Middle Ground Shoal No. 1 which blew out and was controlled and plugged in 1962. Another Pan American well, the Cook Inlet-State No. 1, which was out-of-control and burning in the Inlet for 14 months, is 25 miles northeast of the Shell discovery. Skelly Oil Co., Phillips Petroleum Co., and Sinclair Oil & Gas Co. were participants with Pan American in the Cook Inlet wells.

TABLE 17.—Production of crude petroleum and natural gas

Year	Crude petroleum		Natural gas [1]	
	Thousand barrels	Value (thousands)	Million cubic feet	Value (thousands)
1958	(2)	(2)	50	$6
1959	187	$295	133	16
1960	559	1,230	246	30
1961	6,327	17,652	631	129
1962	10,259	31,187	2,184	467
1963	[3] 10,740	[3] 32,650	4,498	1,111

[1] Comprises gas either sold or consumed by producers, including losses in transmission, quantities added to storage and increases of gas in pipelines.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Preliminary figure.

Activity in exploratory and development drilling centered in the Kenai Peninsula-Cook Inlet area, but a pronounced swing to greater interest in the oil potential of the Arctic Slope was discernible. Many of the major oil companies active in Alaska had geological parties studying the North Slope of the Brooks Range, and geophysical crews—some of the contractors—exploring the Arctic area. Colorado Oil & Gas Corp. drilled the first non-Government oil or gas well north of the Brooks Range at a site about 1 mile up the Chandler River from its confluence with the Colville River, about 20 miles east of Umiat. The well, drilled on the Gubic structure found to be gas bearing in the U.S. Navy's exploration of Naval Petroleum Reserve No. 4 in the early 1950's, was completed as a shut-in gas well late in the year. Sinclair Oil & Gas Co. and British Petroleum Exploration Co. (Alaska), Inc. (BP) had major geophysical work done under contract on the jointly held Chandler River and Outpost development contracts. These adjoining contracts were east of Umiat on the Arctic Slope and covered 612,000 and 574,000 acres, respectively. The Sinclair-BP exploration program presented some interesting sidelights on logistics. Some 2 million pounds of freight, including tractors, fuel, supplies, and food were flown from Fairbanks to spots between Umiat and the Arctic Coast, with landings, in many cases, on frozen lakes.

In new development contracts, Atlantic Refining Co. acquired 597,000 acres near the Arctic Ocean northeast of Umiat. Designated South Ocean Point, the contract called for at least three exploratory wells and expenditure of $1.5 million by the expiration date of December 31, 1968. Shell Oil Co. and Standard Oil Co. of California received a contract on 660,000 acres on the Echooka River about 350 miles north of Fairbanks. The ground is about 50 miles east of Atlantic's South Ocean Point contract. Shell and Standard of California were required to drill at least three exploratory wells and spend not less than $1.5 million by July 1, 1969. The Echooka River contract marked the 13th active development contract in Alaska.

Of major import to the petroleum industry in the State was the reversal by the U.S. Court of Appeals of a lower court decision upholding the rejection by the Secretary of the Interior of 10 applications for oil and gas leases in the Kenai National Moose Range, the location of major oil and gas fields in Alaska (Swanson River field, Kenai unit field). The Court of Appeals held that leases granted on the basis of applications filed prior to August 1958 were invalid because the Range was not open to leasing until that time. The Range was established by executive order in 1941. When interest began to develop in the oil and gas potential of the area, the Department of the Interior drew up leasing regulations and had them published in the Federal Register in August 1958. Later, Interior granted leases on applications filed earlier, mainly in 1954 and 1955. The Court of Appeals decision, if not voided, had drastic implications for oil people. Approximately 350 nonproducing leases and 127 producing leases were in question. Through July, Interior had collected royalties of $7.3 million on 23.5 million barrels of oil and 4.8 billion cubic feet of gas. Allocation and distribution of rights and interests were seen as problems of great magnitude. In the wake of the adverse decision by the Court of Appeals, some 200 new oil lease filings were made over current leases. A considerable number of the new applications were made by Union Oil Co. of California and Marathon Oil Co. over leases they were then holding. Standard Oil Co. of California and Richfield Oil Corp., holders of Swanson River leases, were not reported to have filed new applications.

In developments in natural gas, Standard of California, operator for a group including Richfield and Shell, drilled three additional gas wells in the Beluga River gasfield early in the year. The Beluga River discovery well was drilled in 1962. Studies of possible uses for Beluga gas, including piping it across Cook Inlet for use in repressuring the Swanson River oilfield, continued during the year. At yearend, Standard was rigging up to drill an additional well at Beluga. In the South Barrow gasfield, the U.S. Navy contracted for a new gas well to relieve a fuel shortage in the town of Barrow. Legislation was required to provide funds for the drilling and to permit the sale of gas from Naval Petroleum Reserve No. 4.

Studies and planning for the shipment of liquefied natural gas from the Kenai unit to Japan continued during the year. Union Oil Co. and Marathon Oil Co., lease holders in huge gas reserves on the Kenai Peninsula, announced the formation of two jointly held companies to expedite negotiations for sale of liquid gas to Tokyo Gas Co. for

TABLE 18.—Acreage under oil and gas lease

Year	Thousand acres	Year	Thousand acres
1954–58 (average)	8,317	1961	26,808
1959	34,265	1962	19,550
1960	33,287	1963	14,053

Source: 1954–58 Bureau of Land Management; 1959–63 Geological Survey, U.S. Department of the Interior.

distribution in the world's largest city. Plans called for Polar LMG Corp. to operate a natural gas liquefication plant on the Kenai Peninsula at Kalifonsky Beach, some 75 miles south of Anchorage. The second company, Polar LMG Shipping Co., was to arrange for design and construction of marine tankers and to operate them under contract to Polar LMG Corp. Tankers in the 28,000 to 37,000 deadweight-ton class were under consideration; annual shipments of 220,000 tons were estimated by 1967.

Of 25 wells completed in the State in 1963, 13 were field wells and 12 were wildcats. Total footage drilled was 215,780 feet, only slightly less than the 228,350 feet drilled in 1962. All 12 wildcat wells drilled were dry holes. Shell Oil Co.'s Middle Ground Shoal oil discovery was listed as a field well because it was on the same formation as Pan American Petroleum Corp.'s Middle Ground Shoal-State No. 1, certified as a gas discovery in 1962.

NONMETALS

Gem Stones.—Small quantities of raw jade, most of it from Dall Creek, a tributary of the Kobuk River (Shungnak district, northwestern Alaska region) were produced. Natural gold for specimens and jewelry was reported from the Copper River and the Yukon River regions. Soapstone from the Willow Creek district, Cook Inlet-Susitna region was produced and sold for carvings.

Sand and Gravel.—Both physical volume and value of production of sand and gravel increased markedly over 1962 results. Volume increased almost three times and value four times the 1962 figures. The increases were a result of stepped-up activity by the State Department of Highways as the department accomplished its first full normal operating season following the 1962 reorganization. Value of road work completed by the department in 1963 was 2½ times that of the 1962 season. Also contributing to the increases recorded, however, was more complete coverage of sand and gravel producers in gathering statistics.

Commercial producers accounted for 4 percent of the tonnage and 7 percent of value, compared with 9 and 18 percent, respectively, in 1962. Average value per ton of all sand and gravel was $1.30. Of total output 1.99 million tons (12 percent) valued at $3.20 per ton was washed, compared with 689,000 tons (12 percent) valued at $2.76 per ton in 1962. Value of unwashed sand and gravel was $1.05 ($0.69 in 1962). Ten commercial operators and 13 Federal, State, and municipal agencies or their contractors produced sand and gravel. Commercial producers included The Alaska Railroad, an agency of the U.S. Department of the Interior. The railroad was classified as a

commercial producer to permit comparability with data published for other States.

Of 614,000 tons produced by commercial operators, 553,000 tons (90 percent) valued at $2.78 per ton were washed; the value of unwashed material was $0.54 per ton. For Federal, State, and municipal agencies, output was 16.3 million tons, of which 1.4 million tons (9 percent) valued at $3.37 per ton were washed; unwashed material was valued at $1.05 per ton. The Alaska Department of Highways, the Bureau of Public Roads, and the City of Anchorage were the major producers. The Alaska Department of Highways furnished 94 percent of the tonnage and value credited to State and Federal agencies.

TABLE 19.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Construction:				
Building:				
Sand	112	$478	166	$528
Gravel	242	763	315	880
Paving:				
Sand	109	149	441	746
Gravel	2,398	2,474	1,192	4,109
Fill:				
Sand	33	30	23	14
Gravel	2,761	1,347	14,724	15,673
Railroad ballast:				
Gravel	35	23	30	7
Other:				
Sand	20	55	----	----
Gravel	21	36	----	----
Total construction	5,731	5,355	16,891	21,957
Miscellaneous gravel	----	----	35	48
Grand total	5,731	5,355	16,926	22,005
Commercial:				
Sand	128	352	146	453
Gravel	405	613	469	1,120
Government-and-contractor: [1]				
Sand	146	360	484	835
Gravel	5,052	4,030	15,827	19,597

[1] Approximate figures for operations by the State, counties, municipalities, and other Government agencies under lease.

Stone.—Output of stone decreased 24 percent in tonnage and 55 percent in value from the corresponding figures for 1962. The decreases in both categories were largely a result of changes in use and value patterns by the Alaska Department of Highways. Of total output of stone, Government agencies or their contractors supplied 96 percent of tonnage and 98 percent of value, compared with 97 percent and 99 percent for 1962. The Alaska Department of Highways was again the leading stone producer with 37 percent of tonnage and 49 percent of value. The U.S. Army Corps of Engineers and the Bureau of Public Roads supplied the bulk of the remaining tonnage and value.

REVIEW BY REGIONS

The Kenai Peninsula, with crude oil from Swanson River and natural gas from the Kenai unit supplying by far the greatest part of value, was again the leading mineral producing region in the State. The Yukon River region with sand and gravel, followed by coal and gold, ranked second. Cook Inlet-Susitna had sand and gravel and coal making up almost the entire value of mineral output; the region ranked third.

Kuskokwim River, the only region where metals dominated, had platinum-group metals, gold, and sand and gravel as the leading mineral commodities. There was no production of record from the Alaska Peninsula, Bering Sea, and Bristol Bay regions.

Alaska Peninsula.—Exploration for oil and gas comprised the only mineral activity in the region. At Wide Bay, just south of the entrance to Shelikof Strait, Richfield Oil Corp. drilled an offshore wildcat from a piling platform serviced by a piling causeway 0.5 mile long. The well was plugged and abandoned at 12,566 feet. Gulf Oil Corp. of California drilled Sandy River-Federal No. 1, 20 miles northeast of Port Moller and 8 miles inland. The well was plugged and abandoned at 13,068 feet.

TABLE 20.—Value of mineral production in Alaska, by regions [1]

(Thousand dollars)

Region	1962	1963	Minerals produced in 1963 in order of value
Aleutian Islands	$868	$638	Sand and gravel, stone.
Bristol Bay	53		
Cook Inlet-Susitna	5,601	9,206	Sand and gravel, coal, stone, gold, gem stones, silver.
Copper River	194	3,527	Sand and gravel, stone, gold, silver.
Kenai Peninsula	[2] 31,780	33,801	Petroleum, natural gas, stone, sand and gravel, gold, silver, gem stones.
Kodiak	85	13	Sand and gravel.
Kuskokwim River	1,773	1,206	Platinum-group metals, gold, sand and gravel, mercury, silver.
Northern Alaska	148	159	Natural gas.
Northwestern Alaska	20	25	Gem Stones, gold, silver.
Seward Peninsula	1,828	1,675	Sand and gravel, gold, silver.
Southeastern Alaska	1,128	1,697	Sand and gravel, uranium, stone, gold, silver.
Yukon River	10,714	15,893	Sand and gravel, coal, gold, stone, silver, lead.
Total	[2] 54,192	67,840	

[1] No production reported in Alaska Peninsula and Bering Sea regions.
[2] Revised figure.

Aleutian Islands.—Small quantities of sand and gravel and stone were the only mineral production of record.

Bristol Bay.—Mobile Oil Co. acquired 237,000 acres of oil leases in the Bristol Bay area from Great Basins Petroleum Co., Ambassador Oil Corp., and others. The company carried on geological and geophysical work during the 1963 season.

Cook Inlet-Susitna.—Sand and gravel, and coal from the Matanuska field were the leading mineral commodities, supplying practically all of the $9.2 million production. The region ranked third in value of mineral output.

Value of output of sand and gravel, under the influence of stepped-up road-building activity of the Department of Highways, increased

almost four times over that of 1962. Some of the increase, however, was attributable to better coverage of sand and gravel operators.

Tonnage of coal, all from the Matanuska field, decreased 6 percent and value 17 percent from the figures for 1962. Average value per ton, following the trend of recent years, fell from $9.27 in 1962 to $8.12. All coal was strip mined. Evan Jones Coal Co. continued as the leading producer in the Matanuska field. Mrak Coal Co. and Alaska Matanuska Coal Co. (operating the Premier mine) were other producers. Exploration of the Beluga River coal seams continued. Both Columbia Iron Mining Co. and Utah Development Co. had exploration crews in the Beluga River field.

In exploratory drilling for petroleum, the big event of the year for the region as well as for the State was Shell Oil Co.'s oil discovery in Middle Ground Shoal-State No. 1 in Cook Inlet. In other wildcatting, BP Exploration Co. (Alaska), Inc., drilled a dry hole to 4,849 feet at Wasilla, and Union Oil Co. of California plugged and abandoned Knik Arm-State No. 1 at 6,106 feet. Drilling at yearend were Pan American Petroleum Corp.'s Romig Park No. 1, at Anchorage, Humble Oil & Refining Co.'s Susitna-State No. 1 near Goose Bay, and Mobil Oil Co.'s Salmonberry Lake No. 1 near Lake Louise.

In addition to sand and gravel and coal, small quantities of stone, gold and silver, and gem stones were produced in the Cook Inlet-Susitna region.

Copper River.—Sand and gravel, stone, and small quantities of gold and silver comprised the mineral output of the region. The sand and gravel and the stone were used almost entirely in road building. Gold and silver were produced from the beach placers at Cape Yakataga.

In exploratory drilling for petroleum, Pan American Petroleum Corp. drilled Moose Creek No. 1 near Glennallen to 7,869 feet. The well was plugged and abandoned. White River No. 3, at Yakataga, was drilled to 6,984 feet as a dry hole by BP Exploration Co. (Alaska), Inc. Near Eureka, Aledo Oil Co. drilled Eureka No. 2 to 8,546 feet; it was a dry hole.

Kenai Peninsula.—Oil and gas were again the leading mineral commodities in the region, accounting for more than 99 percent of the value of mineral output. Small quantities of stone, sand and gravel, gold, silver, and gem stones were produced.

The Swanson River field, on a routine operating basis throughout the full year, produced 10.7 million barrels of crude. Repressuring of Swanson River, begun in November 1962, was stabilized at midyear with three wells on gas injection. Gas from upper zones of the Swanson River field was used. The gas injection operation at Swanson River was undertaken for purposes of efficiency and economy only. Reservoir pressures were said to have been sufficient to maintain the 10-million-barrel-production rate for a number of years. At yearend, gas injection was at the rate of 476,000 thousand cubic feet per month; cumulative gas injected to January 1, 1964, was 6.6 million thousand cubic feet.

Volume of natural gas produced and sold from the Peninsula was 4.29 million thousand cubic feet valued at $952,000. The Kenai unit, jointly owned by Union Oil Co. of California and Marathon Oil Co., furnished the bulk of the gas produced. The Union-Marathon group

drilled an additional well during the year. Kenai unit 43–9 was brought in as a gas well in July and shut-in. The new well brought to six the producing wells in the unit; three were producing and three were shut-in. As the year drew to a close, there were strong indications that proposals by Union-Marathon to ship Kenai gas to Japan as liquefied methane gas were progressing apace. In announcing the resignation of a senior vice president, Union stated that the man was to devote full time to the position of president of Polar LMG Corp. Polar LMG Corp. was a subsidiary, formed by Union-Marathon, to operate a natural gas liquefication plant on the Kenai near Kalifonsky Beach. A second subsidiary, Polar LMG Shipping Co., was formed to handle transport of the liquefied gas to market.

In exploratory drilling on the Peninsula, Halbouty Alaska Oil Co. drilled Fritz Creek No. 1 to 3,794 feet. The well, 6 miles east of Homer on Kachemak Bay, was a dry hole. Superior Oil Co. went to 13,528 feet with Happy Valley 31–22, 7 miles southeast of Ninilchik on the west coast of the Peninsula. The well was plugged and abandoned as a dry hole. Sinclair Oil & Gas Co. drilled Mystery Creek No. 1 on the Swan Lake unit to 6,932 feet as a dry hole. The well was about 15 miles east of the Soldatna unit of the Swanson River field.

Kodiak Island.—The U.S. Naval Station on Kodiak reported a small output of sand and gravel. This was the only mineral production of record for the region.

Kuskokwim River.—Platinum, gold, sand and gravel, and mercury were the leading mineral commodities of the reigon; the only region in the State where metals dominated. The region ranked seventh in value of mineral production.

Goodnews Bay Mining Co. continued platinum-dredging operations south of Platinum. Physical volume of output and value were comparable with 1962 results. The company, only producer in the Nation with platinum as the primary product, also produced small quantities of palladium, iridium, osmium, rhodium, ruthenium, and gold. Fremont Mining Co. was again active in exploration of the offshore placer deposits at Goodnews Bay.

At Nyac in the southwestern part of the Kuskokwim, New York-Alaska Gold Dredging Corp. continued to dredge placer gold from deposits on the Tuluksak River. Yardage handled and value of gold recovered were about the same as in 1962. The company was the leading gold producer in the region.

Production of mercury was off sharply. The Red Devil Mine of Alaska Mines & Minerals, Inc., was on exploration work until early August. Results of the work were not announced; when work was suspended the mine was allowed to flood. Red Devil had produced 28,052 flasks of mercury from 1956 to 1963 following the rebuilding of the fire-destroyed mill. The Red Devil output enabled Alaska to rank third among the mercury-producing States of the Nation over this period.

Northern Alaska.—Gas wells on Naval Petroleum Reserve No. 4 supplied 211 million cubic feet of natural gas valued at $158,400 and used at Government agencies and at plants of contractors in Barrow. This was the only mineral production of record.

Colorado Oil & Gas Corp. drilled Gubic unit No. 1 on the North Slope of the Brooks Range, the first exploratory drilling by private interests north of the Arctic Circle. The site, near two gas wells drilled for the Navy on Naval Petroleum Reserve No. 4 in 1951–52, was about 1 mile up the Chandler River from its juncture with the Colville, and about 20 miles east of Umiat. Tested late in the fall, Gubic No. 1 was reported to have flowed 800 to 900 thousand cubic feet per day. Sinclair Oil & Gas Co. and BP Exploration Co. (Alaska), Inc. were associated with Colorado in the Gubic venture.

Northwestern Alaska.—Very small quantities of gem stones, gold, and silver were the only reported mineral output of the region.

Exploration of the Ruby Creek copper deposit near Kobuk by Bear Creek Mining Co. (Kennecott Copper Corp.) was continued. The company had engineering and geological crews studying and evaluating the deposit; no plans for developing Ruby Creek were announced.

Seward Peninsula.—Sand and gravel, gold, and silver were the only mineral commodities of record. Output of gold, reflecting the effect of the close-down of the United States Smelting Refining & Mining Co. dredging operations at Nome, was only a fraction of that of recent years. Six small gold dredges were operated on the Peninsula in 1963. Martinson Brothers, dredging in the Kougarok, was the leading gold producer in the region. Others operating dredges were N. B. Tweet & Sons in the Kougarok, Lee Bros. Dredging Co. at Nome, Inmachuk Mining Co. at Fairhaven, Nugget Mining Co. at Council, and Engstrom & Son Dredging Co. at Nome. Nine nonfloat operations were active in 1963. Leading nonfloat operators were Avon Enterprises at Candle, Patrick J. Bliss at Koyuk, and Ralph DeLong at Nome. Jack Hoogendorn, at Fairhaven, operated the only drift mine reported from the Peninsula.

Exploration for beryllium in the Lost River and Rapid River areas was active. Two of the large mining companies and five or six individuals did drilling, sampling, and geological work on the beryllium showings in the area.

Southeastern Alaska.—Sand and gravel, uranium ore, stone, and minor quantities of gold and silver made up the mineral output of the region. Southeastern Alaska ranked fifth among the regions of the State in value of mineral production.

Operation of the Ross-Adams uranium deposit at Bokan Mountain, Prince of Wales Island, was taken over by Standard Metals Co. from Bay West, Inc. Standard produced 12,000 tons of 1-percent ore in 1963, all of it by underground mining. Ore was moved by barge, rail, and motor truck to the Atlas Mineral Corp.'s mill in southeastern Utah. A spokesman for Standard put production of the Ross-Adams deposit at 40,000 tons to the end of 1963. The deposit was discovered in 1955 and first worked by Kendrick Bay Mining Co., a subsidiary of the former Climax Molybdenum Co., in 1956.

The Bureau of Mines announced discovery of significant amounts of beryllium mineralization in samples collected from around Bokan Mountain. Bureau engineers and technologists were studying the occurrences to evaluate the beryllium potential of the area.

Yukon River.—Sand and gravel, coal, gold, and stone were the leading mineral commodities of the region. Yukon River was second to

the oil producing Kenai Peninsula region in value of mineral output. Value of gold produced dropped sharply. Yardage handled was down only nominally, but value, reflecting the effect of lower grade gravels washed, was 33 percent less that that in 1962. At the close of the season, United States Smelting Refining & Mining Co. (U.S.S.R. & M.) confirmed the closing of its dredging operations in the Fairbanks district. U.S.S.R. & M., the major operator in the Yukon River region, planned to work one dredge cleaning up a remnant of thawed ground on Cripple Creek in the 1964 season. The company planned to continue its single boat operations at Chicken and Hogatza River.

Coal, all of it strip mined, was produced from the Nenana field (Healy River) by Usibelli Coal Mine, Inc., and Arctic Coal Co. Both tonnage and value decreased less than 1 percent from the corresponding figures for 1962; value per ton was unchanged. Vitro Minerals Corp., jointly owned by Rochester & Pittsburgh Coal Co. and Vitro Corp. of America, took over coal lands formerly operated by Cripple Creek Coal Co. at Cripple Creek (Nenana field). Exploratory drilling and other work were done at the Cripple Creek property; coal mining operations were planned for the 1964 season.

Little Squaw Mining Co. proceeded with exploration of the high-grade gold lodes of the Chandalar district, north of the Arctic Circle. The work was done under an Office of Minerals Exploration (OME) contract. Federal Resources Corp. of Salt Lake City, Utah was participating with Little Squaw in the Chandalar venture. Keystone Mine, Inc., was active in exploring a group of claims in the Fairbanks district, also under an OME contract. Keystone accomplished considerable surface exploration during the summer season, changing to underground work in the fall. Some ore from the exploration work was milled at the Hi Yu mill on Moose Creek.

The Mineral Industry of Arizona

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Arizona Bureau of Mines for collecting information on all minerals except fuels.

By L. P. Larson [1]

MINERAL production in Arizona in 1963 totaled $481.4 million—an increase of $7.3 million (2 percent) over that of 1962. The value advanced to within 1 percent of the record high established in 1956. A higher output of copper, with substantial increases in other mineral commodities, was the primary reason for the increase. Arizona mines produced an average of 55,081 tons of copper per month, supplying the Nation with 39 percent of domestic copper requirements and 54.5 percent of the total United States production of 1.2 million short tons. More than 17 percent of the 4 million tons of the copper consumed in the free world was derived from ore mined in Arizona.

The metals group—consisting of copper, gold, lead, mercury, molybdenum, silver, vanadium, zinc, iron ore, and uranium ore—accounted for 91.3 percent of the value of mineral production, followed in order by nonmetals, 8.4 percent, and mineral-fuels group, 0.3 percent. Metals production occurred mainly in Pima, Pinal, Greenlee, and Gila Counties; nonmetals in Pima, Maricopa, and Yavapai Counties; and mineral fuels in Apache County.

Sand and gravel output, ranked second in value of mineral commodities produced in the State, accounted for 36 percent of the value of nonmetals produced and 3 percent of the State total value of mineral output. Used extensively by the construction industry, this commodity declined 3 percent in quantity. Completion of certain phases of construction at the Glen Canyon Dam near Page resulted in a 10-percent decrease in the output of cement.

Mineral output was reported from all 14 counties. The combined value of mineral output from Pima and Pinal Counties was $242.9 million, 50 percent of the State total value of mineral production. All but four of the counties—Graham, Mohave, Santa Cruz, and Yuma—had production valued at more than $1 million.

Development continued at the State newest major copper property, the Duval Corp. Mineral Park copper-molybdenum property near Kingman. In other developments, Inspiration Consolidated Copper Co. announced plans to expand its production in the Globe-Miami area, and The Anaconda Company entered into an agreement with Banner Mining Co. to explore and develop certain properties in the Mineral Hill, Twin Buttes, and Helvetia areas.

[1] Physical scientist, Bureau of Mines, Denver, Colo.

TABLE 1.—Mineral production in Arizona [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate---short tons, gross weight	1	[2]		
Clays [3]---thousand short tons	139	$184	163	$203
Copper (recoverable content of ores, etc.)---short tons	644,242	396,853	660,977	407,162
Gem stones	[4]	120	[4]	120
Gold (recoverable content of ores, etc.)---troy ounces	137,207	4,802	140,030	4,901
Lead (recoverable content of ores, etc.)---short tons	6,966	1,282	5,815	1,256
Lime---thousand short tons	174	2,914	181	3,048
Molybdenum (content of concentrate)---thousand pounds	4,412	5,864	5,553	7,584
Natural gas---million cubic feet	230	27	1,334	161
Petroleum (crude)---thousand 42-gallon barrels	39	[5]	[6] 55	[5]
Pumice---thousand short tons	756	1,640	800	1,877
Sand and gravel---do	15,579	17,404	15,036	14,466
Silver (recoverable content of ores, etc.)---thousand troy ounces	5,454	5,917	5,373	6,873
Stone---thousand short tons	4,333	6,616	3,257	5,069
Tungsten ore and concentrate (60-percent WO_3 basis)---short tons	15	14		
Uranium ore---do	143,196	3,047	150,584	4,844
Vanadium---do	632	[5]	222	[5]
Zinc (recoverable content of ores, etc.)---do	32,888	7,564	25,419	5,846
Value of items that cannot be disclosed: Asbestos, cement, clays (bentonite and fire clay), diatomite, feldspar, gypsum, helium, iron ore, mercury, mica (scrap), perlite, pyrites, and values indicated by footnote 5		[7] [8] 19,883		[9] 17,982
Total		[7] 474,131		481,392

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Less than $500.
[3] Excludes bentonite and fire clay; included with "Value of items that cannot be disclosed."
[4] Weight not recorded.
[5] Figure withheld to avoid disclosing individual company confidential data.
[6] Preliminary figure.
[7] Revised figure.
[8] Value of metals and mineral fuels, $3,453,000; value of nonmetals, $16,430,000.
[9] Value of metals and mineral fuels, $2,320,000; value of nonmetals, $15,662,000.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$237,799	1958	$339,199
1953	263,300	1959	316,513
1954	256,126	1960	379,604
1955	313,110	1961	413,922
1956	358,909	1962	449,744
1957	358,746	1963	420,185

Employment and Injuries.—The Nelson plant of The Flintkote Co., United States Lime Products Division, received recognition from the National Lime Association for its outstanding safety record. As of December 31, 1962, the employees of the Nelson plant completed 2

consecutive years without a single lost-time accident. During this period, the plant employees had no accidents requiring medical attention.

Legislation and Government Programs.—The Federal Government made mineral payments to Arizona totaling $262,317, representing 37.5 percent of the bonuses, royalties, and rentals from mineral leasing on Federal lands within the State.

The Office of Minerals Exploration continued its contract to assist Arizona Metals Co. (formerly Cerbat Mining and Milling Co.) of Los Angeles, Calif., in exploring for silver, lead, and zinc in Mohave County. Total cost of the work was estimated at $49,920; Government participation was to be $24,960.

The U.S. Department of the Interior delegated the State Directors of the Federal Bureau of Land Management in Arizona, Montana, New Mexico, and Utah authority to sign United States patents, a procedure that speeded processing of patent requests.

The Department of the Interior also issued a new policy statement regarding sale of public lands. In the future, the Government will reserve the right to reject any and all bids before final certificates are issued. The bid on the date of sale must not be less than the fair market price.

The Bureau of Land Management issued a lease for 2,592 acres of Federal public lands to Maricopa County Regional Parks System on April 19. The acreage, located 1.5 miles west of Cave Creek, brought to over 70,000 acres the amount of Federal public lands taken into the Maricopa County Regional Parks System within 18 months. All leases were issued under provisions of the Recreation and Public Purposes Act. The price schedule allowed counties and other qualified State and local agencies to lease recreation, school, and public purpose sites for 25 cents per acre or to purchase them at $2.50 per acre.

Regulations governing the administering of the Johnson-Church Bill (Public Law 87–851 to provide relief for residential occupants of unpatented mining claims on which valuable improvements have been placed) were published by the Department of the Interior as Circular 2093. The regulations which appeared in the Federal Register for December 13, 1962, became effective on publication.

The Federal Power Commission issued a 50-year license to Phelps Dodge Corp., Douglas, for a proposed hydroelectric power project in Coconino and Gila Counties. The proposed $6.7 million project to be located on East Clear Creek, a tributary of Little Colorado River, was to be known as the Blue Ridge Project.

The Arizona State Legislature in regular session enacted a measure to permit the State Land Department to lease State land for periods up to 50 years for commercial purposes within a 3- to 5-mile radius of cities. The act limits such leases to within 3 miles of cities or towns under 10,000 population, or 5 miles of cities and towns over 10,000 population. It also requires that the land be appraised and the lease awarded on the basis of the highest competitive bid and that the bid price be subject to revision every 5 years.

Sand and gravel and stone were used by contractors of the Federal Bureau of Public Roads, Arizona State Highway Department, and county highway departments in constructing interstate, State, and

county highways throughout the State. A report [2] showed that from July 1956 to December 31, 1963, Arizona completed to full or acceptable standards 324.6 miles of road, plus 253.3 miles of highway improved to standards adequate for present traffic, a total of 577.9 miles open to traffic. Work in progress with interstate funds included 40.4 miles under construction and 359.3 miles in engineering or right-of-way status, a total of 399.7 miles. In mileage completed, Arizona was ranked 8th in the Nation; in total underway, it was 15th. The Arizona State highway contracting program [3] in 1963 included $1 million in State-financed roads, $13 million in the Federal-aid primary and secondary (ABC) contracts, and $43 million in interstate highway contracts, a total of $57 million. Planned for 1964 were $2 million in State-financed roads, $13 million in ABC contracts, and $40 million in contracts for interstate roads. This projection totaled $55 million, representing an increase of 100 percent in State-financed roads and a 7-percent decrease in interstate contracts, an overall reduction of 4 percent in outlay for road construction in 1964 from that of 1963.

Water.—The Federal Bureau of Mines conducted a nationwide survey of water used during 1962 in the mineral industries; from this survey, table 3 depicts specific results for Arizona.

TABLE 3.—Water used during 1962 in the mineral industry, by type of operations
(Million gallons)

Type of operation [1]	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	27		27	2	25	4.04
Metal mines and mills	26,214	49,949	76,163	12,890	13,324	61.64
Nonmetal mines and mills	(2)		(2)	(2)		.13
Sand and gravel operations	1,063	253	1,316	919	144	61.06
Total	27,304	50,202	77,506	13,811	13,493	
Oil- and natural-gas-well drilling [3]			5			
Grand total			77,511			

[1] Water survey did not include cement plants, lime plants, metal smelters, metal refineries, petroleum refineries, natural-brine operations, sand and gravel operations using suction dredges without preparation plants, stockpile operations, and assessment work operations.
[2] Less than 1 million gallons.
[3] No secondary-recovery operations in Arizona.

REVIEW BY MINERAL COMMODITIES

METALS

Copper.—Arizona retained its position—held since 1910—as the leading copper-producing State, accounting for more than one-half of the Nation's copper output. New developments either planned or underway together with the modernization and expansion of existing plants were expected to provide sufficient additional capacity to assure producers in the State their share of the market.

[2] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1963. Press Release BPR 64–9, Feb. 7, 1964.
[3] Engineering News-Record. State Highway Contracts Will Rise. V. 172, No. 13, Mar. 26, 1964, pp. 13–15.

Domestic prices for copper, stable throughout the year, resulted in a 31-cent-per-pound price for the 3d year. This stability, combined with assurance of adequate supplies, encouraged and promoted the use of copper, contributed to reduction of stocks, and encouraged producers to increase output. At yearend, Phelps Dodge Corp. and other major producers were considering increasing copper production at their Arizona properties by reinstating certain closedown days in their production schedules. During 1963 Phelps Dodge Corp. operated its properties at Ajo, Bisbee, Douglas, and Morenci at about 90 percent of capacity. Inspiration Division, Inspiration Consolidated Copper Co., mined and treated ore at 90 percent of capacity for the first 9 months of 1963. In the 4th quarter, as demand improved and the Christmas Division production failed to reach expected levels, production at the Inspiration Division was increased 10 percent to capacity level. Lower output at the Ray pit, operated

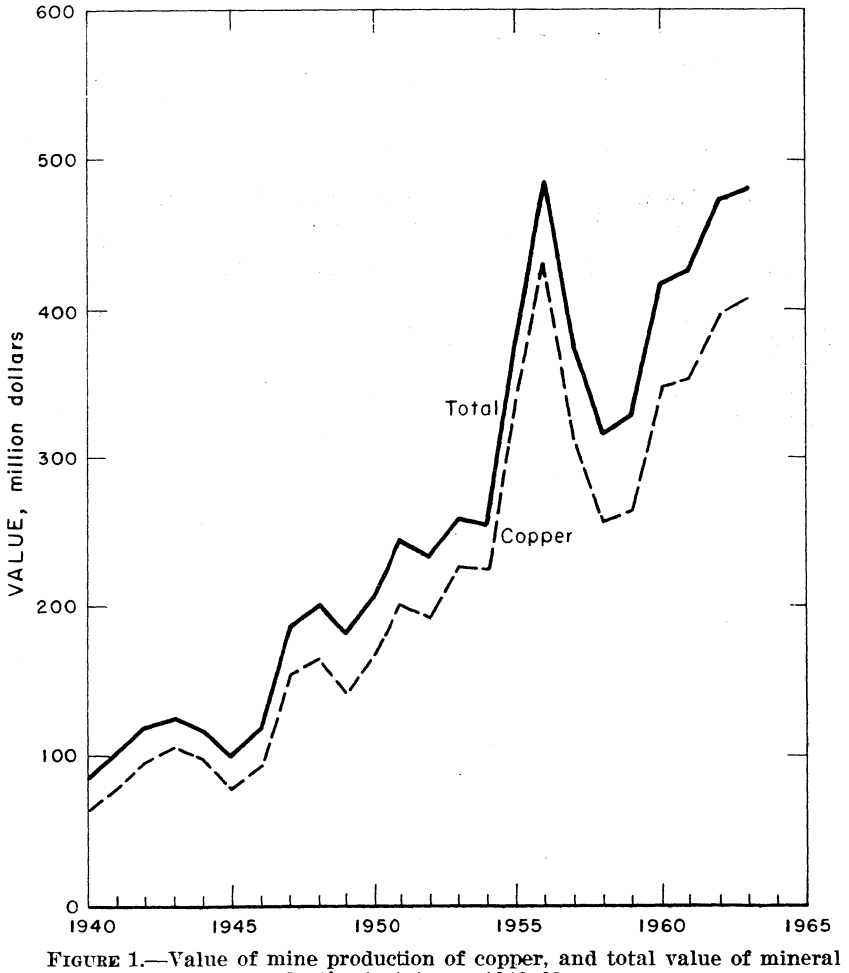


FIGURE 1.—Value of mine production of copper, and total value of mineral production in Arizona, 1940–63.

by Kennecott Copper Corp., reflected the reduction in the operating rate effected on September 16, 1962, to bring production in line with demand. In the 4th quarter of 1963, production at Ray was intensified to meet increased demand.

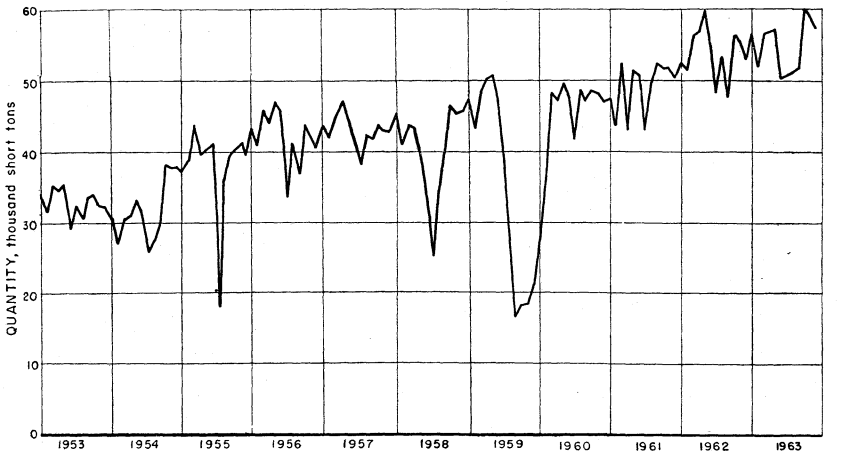


FIGURE 2.—Mine production of copper in Arizona, 1953–63, by months, in terms of recoverable metal.

TABLE 4.—Fifteen leading copper-producing mines in 1963, in order of output

Rank in 1963	Rank in 1962	Mine	District	County	Operator	Source of copper in 1963
1	1	Morenci	Copper Mountain.	Greenlee	Phelps Dodge Corp.	Copper ore and precipitates, gold-silver ore.
2	2	San Manuel	Old Hat	Pinal	Magma Copper Co., San Manuel Div.	Copper ore.
3	3	Lavender pit, Copper Queen.	Warren	Cochise	Phelps Dodge Corp.	Copper ore, copper precipitates.
4	4	New Cornelia	Ajo	Pima	do	Copper ore, gold-silver ore.
5	5	Ray pit	Mineral Creek	Pinal	Kennecott Copper Corp.	Copper ore, copper precipitates.
6	7	Mission	Pima	Pima	American Smelting and Refining Co.	Copper ore.
7	6	Inspiration	Globe-Miami	Gila	Inspiration Consolidated Copper Co.	Copper ore, copper precipitates.
8	9	Silver Bell	Silver Bell	Pima	American Smelting and Refining Co.	Copper ore, copper precipitates, copper cleanup.
9	8	Esperanza	Pima	do	Duval Corp	Copper ore, copper precipitates.
10	10	Copper Cities	Globe-Miami	Gila	Tennessee Corp., Miami Copper Co. Div.	Do.
11	13	Bagdad	Eureka	Yavapai	Bagdad Copper Corp.	Do.
12	12	Magma	Pioneer	Pinal	Magma Copper Co.	Copper ore, gold-silver ore.
13	------	Daisy	Pima	Pima	Banner Mining Co. and Pima Mining Co.	Copper ore.
14	11	Pima	do	do	Pima Mining Co.	Do.
15	------	Christmas	Banner	Gila	Inspiration Consolidated Copper Co.	Do.

TABLE 5.—Ore mined, waste and leach material removed, and total copper production at principal copper open-pit and underground mines

(Short tons)

Mine	Ore mined		Waste and leach material removed		Total copper produced from all sources [1]	
	1962	1963	1962	1963	1962	1963
Open pit:						
Morenci	16,983,000	17,141,000	26,539,000	27,985,000	121,302	121,220
New Cornelia	9,648,000	9,370,000	14,892,000	16,703,000	71,008	67,206
Ray	7,695,757	7,123,102	[2] 15,070,961	[2] 14,899,836	66,475	62,930
Mission	[2] 5,223,500	7,318,100	[2] 23,810,200	26,194,200	[3]	[4] 50,476
Inspiration	5,552,219	5,487,483	3,932,641	6,005,629	52,291	46,937
Lavender	5,374,000	5,347,000	14,064,000	15,781,000	41,784	38,266
Silver Bell	[2] 2,760,600	2,948,100	[2] 2,799,850	[2] 5,848,300	[3]	[5] 23,589
Esperanza	[2] 4,245,504	[2] 4,364,029	[2] 5,926,620	[2] 2,191,309	[5] 22,974	[5] 23,393
Copper Cities	3,150,952	3,149,260	2,027,321	5,119,846	[4] 17,437	[5] 21,834
Bagdad	[2] 1,965,764	[2] 2,094,671	[2] 8,246,800	[2] 1,089,200	[5] 14,248	[5] 17,658
Daisy-Pima	[2] 1,875,458	1,993,000	[2] 6,165,844		[3]	[3]
Underground:						
San Manuel	12,565,545	12,555,000			84,208	88,536
Copper Queen	618,000	715,000			30,742	33,071
Magma	337,618	310,039			14,913	14,131
Christmas	[6] 75,108	638,755			[3]	10,116
Miami	[7]	[7]			[8] 9,201	[8] 9,263

[1] Includes copper recovered from leaching of material in place and in dumps.
[2] Metal Mining & Processing (formerly Mining World), May 1964, p. 39.
[3] Figure withheld to avoid disclosing company confidential data.
[4] Gross metal in concentrate shipped.
[5] Gross metal in concentrate and precipitates shipped.
[6] Metal Mining & Processing (formerly Mining World), May 1964, p. 47.
[7] All production from in-place leaching.
[8] Gross metal in precipitates shipped.

Source: Bureau of Mines data or company-published annual reports except where otherwise specified.

TABLE 6.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1954–58 (average)	154	6	54,831	136,793	$4,788	4,815	$4,358
1959	101	3	53,732	124,627	4,362	3,898	3,528
1960	106	5	66,800	143,064	5,007	4,775	4,322
1961	96	4	72,537	145,959	5,109	5,120	4,733
1962	83	5	79,583	137,207	4,802	5,454	5,917
1963	90	4	81,214	140,030	4,901	5,373	6,873
1860–1963	[3]	[3]	[3]	13,016,934	343,088	375,260	295,088

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	467,927	$311,571	10,906	$3,066	26,432	$6,182	$329,965
1959	430,297	264,202	9,999	2,300	37,325	8,585	282,977
1960	538,605	345,784	8,495	1,988	35,811	9,239	366,340
1961	587,053	352,232	5,937	1,223	29,585	6,804	370,101
1962	644,242	396,853	6,966	1,282	32,888	7,564	416,418
1963	660,977	407,162	5,815	1,256	25,419	5,846	426,038
1860–1963	19,087,663	7,877,896	627,559	122,210	938,592	226,014	8,864,296

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes re-treated, and ore, old tailings, or copper precipitates shipped to smelters during the calendar year indicated.
[2] Does not include gravel washed or tonnage of precipitates shipped.
[3] Data not available.

TABLE 7.—Mine production of gold, silver, copper, lead, and zinc in 1963, by counties, in terms of recoverable metals

County	Mines producing [1]		Material sold or treated [2] (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
Cochise	6		6,091,130	44,455	$1,555,925	757,679	$969,162
Coconino	3		197,210			8,708	11,139
Gila	11		9,293,121	3,851	134,785	242,240	309,854
Graham	1		24			165	211
Greenlee	2		17,140,821	10,925	382,375	521,110	666,562
Maricopa	4		1,420	75	2,625	3,940	5,040
Mohave	3	1	89	102	3,570	349	446
Navajo			[3]			4,399	5,627
Pima	18		25,931,629	33,088	1,158,080	2,065,196	2,641,634
Pinal	13		20,039,295	29,531	1,033,585	859,546	1,099,462
Santa Cruz	8		13,533	15	525	19,679	25,172
Yavapai	16		2,505,886	17,919	627,165	889,876	1,138,258
Yuma	5	3	359	69	2,415	171	219
Total:							
1963	90	4	81,214,517	140,030	4,901,050	5,373,058	6,872,786
1962	83	5	79,528,726	137,207	4,802,245	5,453,585	5,917,140

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Cochise	71,893	$44,286,211	25	$5,335	393	$90,436	$46,907,069
Coconino	576	354,631					365,770
Gila	90,254	55,596,218					56,040,857
Graham	[4]	123					334
Greenlee	121,220	74,671,551					75,720,488
Maricopa	3	1,540	1	238			9,443
Mohave							4,016
Navajo	419	257,981			3	621	264,229
Pima	186,944	115,157,627	49	10,541	1,280	294,331	119,262,213
Pinal	166,764	102,726,624	17	3,618	1	299	104,863,588
Santa Cruz	16	10,102	340	73,591	408	93,748	203,138
Yavapai	22,879	14,093,403	5,383	1,162,717	23,334	5,366,935	22,388,478
Yuma	9	5,821					8,455
Total:							
1963	660,977	407,161,832	5,815	1,256,040	25,419	5,846,370	426,038,078
1962	644,242	396,853,072	6,966	1,281,744	32,888	7,564,240	416,418,441

[1] Operations at miscellaneous cleanups not counted as a producing mine.
[2] Does not include gravel washed or tonnage of precipitates shipped.
[3] Byproduct of uranium ore.
[4] Less than 0.5 ton.

TABLE 8.—Mine production of gold, silver, copper, lead, and zinc in 1963, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold	4	80	50	76	300		
Dry gold-silver	8	117,705	383	12,519	1,903,400		
Dry silver	22	31,067	5	10,307	272,600		
Total	34	148,852	438	22,902	2,176,300		
Copper	34	80,615,132	121,177	4,494,239	1,217,337,700	22,200	506,300
Copper-zinc	4	116,251	154	45,560	8,608,000	57,800	15,575,500
Lead	9	2,127	33	10,982	7,400	355,900	22,100
Lead-zinc	2	293,021	17,486	766,898	657,100	11,105,500	32,531,200
Zinc	2	8,454		6,299	18,500	84,900	2,197,400
Total	50	81,034,985	138,850	5,323,978	1,226,628,700	11,626,300	50,832,500
Other "lode" material:							
Gold mill cleanup	[2]	20	43	43			
Gold tailings	1	50	26	13			
Gold-silver tailings	2	28,891	570	11,835	73,900		
Copper cleanup	[2]	1,715	49	1,220	526,400		100
Copper precipitates	14	67,841			91,236,600		
Lead cleanup	[2]	4	1	7		3,700	
Uranium ore				13,055	1,312,100		5,400
Total	17	98,521	689	26,173	93,149,000	3,700	5,500
Total "lode" material	90	81,282,358	139,977	5,373,053	1,321,954,000	11,630,000	50,838,000
Placer	4		53	5			
Total all sources	94	81,282,358	140,030	5,373,058	1,321,954,000	11,630,000	50,838,000

[1] Detail will not necessarily add to totals because some mines produce more than one class of material.
[2] From properties not classed as mines.

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc in 1963, by types of material processed and methods of recovery, in terms of recoverable metals

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Amalgamation: Ore	29	6			
Concentration and smelting of concentrates:					
Ore [1]	122,226	4,945,087	[2] 1,192,490,500	11,394,500	50,826,700
Old tailings	26	13			
Total	122,252	4,945,100	[2] 1,192,490,500	11,394,500	50,826,700
Direct-smelting:					
Ore	17,033	414,842	37,626,600	231,800	11,200
Cleanings	93	1,270	526,400	3,700	100
Copper precipitates			91,236,600		
Old tailings	570	11,835	73,900		
Total	17,696	427,947	129,463,500	235,500	11,300
Placer	53	5			
Grand total	140,030	5,373,058	1,321,954,000	11,630,000	50,838,000

[1] Includes uranium ore concentrate.
[2] Includes copper recovered from leaching of ore at one operation that employs dual-process treatment of leaching followed by flotation concentration, and from one operation engaged in heap leaching of copper ore; combined to avoid disclosing individual company confidential data.

Labor difficulties at the Palo Verde mine, owned and operated by Banner Mining Co., resulted in loss of about 3,300 tons of metal. The mine was closed by a strike called by the International Union of Mine, Mill, and Smelter Workers on May 27, 1963, and remained closed during the remainder of the year. Labor agreements at many of the large Arizona operations were to expire in mid-1964.

Arizona mines produced an average of 55,081 tons of copper per month, 54.5 percent of the Nation's output. More than one-sixth of the free-world output of copper originated at mines in the State.

Although many small mines had output of high-grade ores, the large low-grade ore deposits operated by the large copper companies accounted for most of the copper. Open-pit mines in Cochise, Gila, Greenlee, Pima, Pinal, and Yavapai Counties supplied about 75 percent of the State total output; underground mines including Christmas, Copper Queen (Cyprus Mines), Copper Queen (Phelps Dodge), Magma, Miami, Old Dick, Palo Verde, and San Manuel accounted for most of the remaining production.

Eighty-five operators reported production. The 5 leading producers reported output of 412,023 tons or 62 percent of the State total; the first 10 major producers accounted for 575,137 tons or 87 percent; and the first 15 producers 639,629 tons or 97 percent of the total.

Completed pilot-plant studies conducted by Bagdad Copper Corp. on the refining of copper precipitates to pure powder were reported to be successful. Results of the study indicated that production, to be economic, must be at a rate beyond the ability of the market to absorb power. Fabrication of a substantial amount of the powder into such shapes as wire, sheet, or tube was therefore considered a necessity. The company was considering using tube fabrication because production techniques were solved and because this product would provide the company with a greater margin of profit than sheet or wire. Further economic analysis was required to insure the company that it would be in a competitive position within the market if the plant were built.

Banner Mining Co. signed an agreement with The Anaconda Company granting Anaconda an exclusive option for leasing, exploring, developing, and financing substantially all mining property of Banner Mining Co. located in Pima County. An exception was that area of the Banner property, a part of the Pima pit, which was being mined and milled under contract by Pima Mining Co.

Duval Corp., formerly Duval Sulphur and Potash Co., proceeded with plans to develop and place in operation the company copper-molybdenum deposit in the Mineral Park mining district, 15 miles northwest of Kingman.

Isbell Construction Co. began removing an estimated 18 million tons of waste material overlying the ore deposit in January and by yearend had removed approximately 9 million tons. Stripping the waste from the 5,206-foot elevation to the 4,915-foot level was expected to cost $7 million and require 20 to 24 months on a 24-hour-day schedule. The company was reported to control 7,000 acres in the Mineral Park district.

The $21 million 12,000-ton-per-day mill now under construction by Parson-Jurden was to use autogenous grinding for reducing the

porphyry-type rock. The ore was to be crushed to minus 5/8 inch in cone crushers and fed to four 20-foot-diameter by 10-foot-long 3,000-ton-per-day Marcy autogenous primary and secondary grinding mills. Water for the mill was to be obtained from the Sacramento Valley. In addition to producing copper and molybdenum concentrates, the company was to install a molybdenum oxide plant to produce pure molybdenum trioxide for direct sale to steel mills.

In March, the company began removing waste material overlying the satellite copper-molybdenum ore body located immediately west of the main Esperanza pit. Six million tons of capping were to have been removed when stripping is completed in 1965. Ore from this deposit, known as the West Esperanza ore body, was to be mined and milled concurrently with ore from the main pit.

Ray Mines Division, Kennecott Copper Corp., authorized expenditure of $500,000 for facilities to leach the No. 1 dump adjacent to the Pearl Handle open pit and to install a continuous X-ray system to analyze tailing streams from various units of the Hayden reduction plant. During the year, the Ray Mines Division removed ore and waste material from the Pearl Handle and West pits and from the southeastern extension to the Pearl pit. About midyear, the division began stripping east of Mineral Creek and mining under the Ray business section which had been demolished and made part of the pit. By 1965 the entire community is to be included in the Pearl Handle part of the open pit.

Kennecott Copper Corp. reported that the comprehensive economic evaluation of its Safford copper deposit was completed. The study followed completion of the underground drilling program in December 1962 and the conclusion of tests at the pilot plant designed to test the feasibility of the leaching process. The company had placed the plant on standby under the management of Ray Mines Division.

Bear Creek Mining Co., Kennecott Copper Corp. exploration subsidiary, received exclusive right from the Gila River Tribal Council to conduct a mineral-exploration program on 19,200 acres of tribal lands on the Gila River Indian Reservation near Sacaton. The area involved lies in two tracts, one about 10 miles northeast of Sacaton, Pinal County, and the other about 5 miles to the south. The permit, in force for 2 years, excludes oil and gas exploration.

In January, McFarland & Hullinger terminated operations at the Johnson Camp mine near Willcox, Cochise County; the Republic mill was closed shortly thereafter. Depletion of ore reserves was given as the reason for the shutdown. In other actions, the company transferred its silica operation from the Mammoth tailing dump to the Tiger tailing dump and was making regular shipments to the American Smelting and Refining Co. (Asarco) smelter at Hayden. The mill tailing contained 85 percent silica and small amounts of gold, silver, and copper. Both dumps are located in Pinal County.

The Phelps Dodge Corp., properties at Ajo, Bisbee, Douglas, and Morenci were operated without interruption throughout 1963 except for the regular 2-week summer shutdowns for vacations. Operating schedules at the various mines were curtailed to about 90 percent capacity. Concentrator capacity was increased about 7 percent with

the installation of two new grinding mills. Other major capital expenditures by the company in 1963 included the beginning of construction work on a leach-precipitation-flotation system to recover part of the oxide copper present in the Morenci ore and partial completion of the Blue Ridge Dam project. Research to increase the continuity of operations at the sponge-iron plant at the Douglas smelter was continued throughout the year. Improvements made during the year permitted the 25-ton-per-day sponge-iron plant to be operated at a near-continuous rate and to reduce the cost of manufacturing sponge iron. Construction was underway at the end of the year to increase the capacity to 50 tons per day. Sponge iron obtained from the plant was used as a precipitant of copper from solutions obtained in the dump-leaching operations at Bisbee. The sponge iron produced was to replace tin cans.

Phelps Dodge Corp. received a license from the Federal Power Commission to build the $6.7 million Blue Ridge hydroelectric-irrigation project in Coconino and Gila Counties. Construction of the dam for this project on East Clear Creek, a tributary of Little Colorado River in central Arizona, was begun in May. Pouring of the 150-foot concrete arch-dam structure was completed. Work was begun on the 8.5-mile tunnel to deliver water impounded behind the dam into East Verde River in exchange for water to be diverted from Black River for use in the Morenci operations.

In August, Pima Mining Co. completed an expansion program at its mill south of Tucson. The new facility was designed to increase daily mill capacity from 3,800 to 7,000 tons. During the year the company stripped overburden from the west end of the northeast ore body and from the east end of the main pit. Most of the ore came from the west and central part of the pit, including ore mined from across the line on Banner Mining Co. property. In accordance with the agreement between the two companies the ore was milled at the Pima mill.

Shattuck Denn Mining Corp. began production on the 2,000-foot level of a recently discovered copper vein at its Iron King mine near Prescott. The copper vein, near and parallel to the main ore-vein system in the mine, was uncovered during an intensive revaluation and drilling program conducted during the past 2 years. Drilling indicated that the new mineralized ore body contained a higher percentage of copper than that of the normal Iron King ore. The output from the Iron King mine gained impressively near the end of the year following the introduction of a more efficient one-level mining operation employing highly mechanized equipment. At the start of the year, production was from four separate workings above the 2,200-foot level. By midyear the 2,200-foot level was put into operation; by yearend the monthly production from the level totaled 20,000 tons. The number seven shaft had reached the 2,500-foot level, and an access station was being cut on the 2,400-foot level. Drifting to the ore zone on the 2,300-foot level began in the last quarter of 1963. The Iron King mine has been a major producer of zinc, lead, silver, and gold for many years; copper was produced only as a byproduct.

Leaching operations were started by Zontelli Western Mining Co. at the Mardun sandstone-copper deposit in the White Mesa district,

Coconino County. During the year the company received a loan of $66,500 from the Small Business Administration to develop the property.

Gold.—Gold production from 48 lode and 4 placer mines in Arizona totaled 140,030 troy ounces, 2 percent (2,823 ounces) more than that of 1962. Eighty-seven percent was recovered as a byproduct of copper refining; 12 percent from lead-zinc ores; and the balance from gold-silver, copper-zinc, gold, lead, and silver ores and miscellaneous lode material.

Phelps Dodge Corp. was the largest producer, accounting for more than 50 percent of the total output. According to the company annual report, the combined output of gold recovered as a byproduct of the refining of copper ores obtained from the Copper Queen, Morenci, and New Cornelia Branches, together with minor amounts recovered from purchased ores, totaled 89,000 troy ounces, compared with 90,000 ounces in 1962 and 94,000 ounces in 1961.

Magma Copper Co., the State second largest producer, accounted for 20 percent of the total production of gold. According to the company annual report, 27,409 ounces of gold was recovered from ores obtained from the Magma and San Manuel mines and from custom ores.

Shattuck Denn Mining Corp., Iron King mine, the third largest producer of gold in the State, was the largest producer of gold from lead-zinc ores.

Joseph P. Gruedel, Wickenburg, recovered a small quantity of gold and silver by processing mill tailing from the Tom Reed dump near Oatman, Mohave County. Americana Investments, Inc., Oatman, planned to recover gold and silver from processing 1 million tons of tailing at the old millsite as well as ore from mines in the Oatman district. The company acquired a 5-year lease on the White Chief mine owned by Triumph Gold Mines Co. A steel headframe was installed, the hoist reconditioned, and the shaft repaired to the 200-foot level.

The old Harqua Hala mine, in Ellsworth district, Yuma County, near Salome, was reactivated.

Forty lode and four placer mines supplied the balance of the production. Cochise, Pima, and Pinal were the leading gold-producing counties in the State, accounting for 76 percent of the total production.

Iron Ore.—The Omega mine operated by Arkota Steel Corp. and the New Planet mine operated by Pacific Mines, Inc., were idle. Arkota Steel Corp. reported shipping a small quantity of concentrate from stockpile for use in precipitating copper. Magnetite ore produced from the Margaret Howard mine in Gila County was sold for use as a processing agent. Sponge iron was produced from pyrite by Ray Mines Division at Hayden and from iron oxides obtained in the smelting process by Phelps Dodge Corp. at Douglas.

Phelps Dodge Corp. studied methods for increased continuous operation of the company sponge-iron plant at Douglas. Improvements made during the year enabled the 25-ton-per-day plant to be operated at a near-continual rate and to reduce the cost of making sponge iron. At the end of the year, construction work was underway to increase the daily capacity of the plant to 50 tons. The sponge iron obtained

from this plant was being used as a precipitant of copper from solutions obtained from dump-leaching operations at Bisbee.

Lead.—Lead production was 1,151 tons (17 percent) lower in quantity but only 2 percent lower in value compared with that of 1962; it was the lowest production of lead reported in the State since 1934. Most of the production came from lead-zinc ores of the Iron King mine operated by Shattuck Denn Mining Corp. in Yavapai County. The Flux mine in the Harshaw district of Santa Cruz County, operated by Nash & McFarland, was the second largest producer. Yavapai County, with five operations, led the State with 5,383 tons or 93 percent of the production. Santa Cruz County, with four operations, was second, accounting for 6 percent of the output. Eleven operations in four counties—Cochise, Maricopa, Pima, and Pinal cumulatively—furnished 1 percent of the production.

Mercury.—Mercury production, increasing fivefold compared with that of 1962, came from a mine in the Mazatzal Mountains north of Sunflower in Maricopa County, the State principal mercury-producing area, and from mill cleanup in Gila County.

Molybdenum.—Ranked third in the Nation behind Colorado and Utah, Arizona accounted for slightly more than 8 percent of the Nation's total output of molybdenum. Production was derived as a by-product from the processing of copper ores. Molybdenum production from six of the State major copper operations increased 26 percent in quantity and 29 percent in value during the year as a result of new or modernized facilities. Shipments of molybdenum concentrates contained 5.6 million pounds of molybdenum valued at $7.6 million. The average price of molybdenum in concentrates was $1.37 per pound, compared with $1.33 per pound in 1962. Exports of molybdenum concentrates from mines in Arizona totaled 936,448 pounds, or 17 percent of the total shipments. Compared with the previous year, this amount represented an increase of 153 percent in quantity of material exported. Stocks of molybdenum concentrates on hand December 31 contained 158,217 pounds of molybdenum, 198,346 pounds less than was on hand December 31, 1962. Listed in decreasing order of production, the mines and operators were San Manuel, San Manuel Division, Magma Copper Co.; Esperanza, Duval Corp.; Silver Bell, Asarco; Inspiration, Inspiration Division, Inspiration Consolidated Copper Co.; Morenci, Phelps Dodge Corp.; and Bagdad, Bagdad Copper Corp.

Duval Corp. reported that molybdenum production from the Esperanza mine was less than that of 1962 because of a lower molybdenum content of the mill feed. Molybdenum sales by the company were in balance with production and high demand.

In December Asarco authorized and began construction of a molybdenum recovery plant at the Mission mine.

Modification of the molybdenum process and plant at the Inspiration Division in 1962 improved recovery, product quality, and ability to accommodate wide fluctuations in mill feed.

Ray Mines Division conducted experimental work in preparation for producing molybdenum at its completed pilot plant.

Silver.—Silver production increased in value but decreased in quantity. Most of the output was from mines operated primarily

for other metals: 84 percent was recovered from copper ores; 14 percent from lead-zinc ores; and the remainder from complex ores of gold, silver, copper, lead, and zinc and from miscellaneous materials. The five leading producing companies—Phelps Dodge Corp., Asarco, Shattuck Denn Mining Corp., Magma Copper Co., and Pima Mining Co.—accounted for 83 percent of the State total output. Counties in which production occurred—listed in order of descending production—were Pima, Yavapai, Pinal, Cochise, Greenlee, Gila, Santa Cruz, Coconino, Navajo, Maricopa, Mohave, Yuma, and Graham.

The price of silver in New York fluctuated within a range of 8.3 cents a troy ounce—from $1.21 per ounce on January 2 to $1.293 on September 9 where it remained unchanged for the balance of the year. The annual weighted average price was $1.279 per troy ounce, compared with $1.085 per ounce in 1962 and $0.92449 per ounce in 1961.

Uranium Ore.—Arizona was ranked fifth in the Nation in uranium-ore production. Thirty-eight operations in Apache, Coconino, and Navajo Counties were active in 1963, compared with 31 operations in 1962. Shipments of uranium ore totaled 150,584 short tons valued at $4.8 million, an increase of 5 percent in quantity and 59 percent in value. The value of the ore f.o.b. mine ranged from $1.96 per ton to $47.50, averaging $32.17 per ton during the year. In 1962, the f.o.b. mine value ranged from $4.00 per ton to $84.50, averaging $21.28 per ton. Average grade of ore shipped from mines in Arizona during the year was 0.37 percent uranium oxide (U_3O_8). The grade of ore ranged from 0.07 to 0.53 percent U_3O_8, compared with from 0.10 percent to 0.90 percent in 1962. The large increase in average value per ton and in the total value given for mine shipments was primarily the result of an increase in mine shipments of higher grade ore from the Orphan mine where operations, after being inactive since December 1961, were resumed in the 3d quarter of 1962. Uranium ore mined in Arizona was shipped to uranium processing mills at Tuba City (El Paso Natural Gas Co.), Durango, Colo. (Vanadium Corporation of America [VCA]), Grand Junction, Colo. (Climax Uranium Co., a unit of Climax Division, American Metal Climax, Inc.), Rifle and Uravan, Colo. (Union Carbide Corp., Union Carbide Nuclear Co. Division), Grants, N. Mex. (Kermac Nuclear Fuels Corp.), Shiprock, N. Mex. (VCA), and Mexican Hat, Utah (Atlas Minerals Division, Atlas Corp., successor in July to Texas-Zinc Minerals Co.).

TABLE 10.—Mine production of uranium ore, by counties[1]

County	1962				1963			
	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value[2]	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value[2]
Apache	20	88,217	407,190	$1,655,597	29	51,622	238,940	$945,819
Coconino	4	404	1,744	6,898	3	62,097	660,279	2,940,668
Navajo	7	54,575	326,660	1,384,411	6	36,865	223,283	957,495
Total	31	143,196	735,594	3,046,906	38	150,584	1,122,502	4,843,982

[1] Receipts at mills based on data supplied to the Bureau of Mines by AEC.
[2] F.o.b. mine value; base price, grade premiums, and exploration allowances. Calculated according to AEC Circular 5, Revised, price schedule.

Vanadium.—Uranium ores from Apache and Navajo Counties were processed at vanadium recovery units at uranium plants operated by Climax Uranium Co., Grand Junction, Colo.; Union Carbide Nuclear Co., Rifle and Uravan, Colo.; and VCA, Durango, Colo., and Shiprock, N. Mex. (New Mexico plant formerly owned by Kerr-McGee Oil Industries, Inc.). The quantity of fused vanadium oxide recovered was 65 percent below that of 1962.

Zinc.—Zinc production in Arizona was 23 percent lower in quantity and 23 percent lower in value. Following the Iron King mine, the principal producers of zinc in the State, in order of production, were the Copper Queen and Old Dick mines (Cyprus Mines Corp.), Atlas mine (B S & K Mining Co.), Johnson Camp mine (McFarland & Hullinger), and Flux mine (Nash & McFarland). These six mines supplied 99 percent of the Arizona zinc output.

NONMETALS

Asbestos.—Production of asbestos from mines near Globe, Gila County, increased during the year. Jaquays Mining Corp., operator of the Regal and Chrysotile mines in the Salt River canyon district, was the leading producer, and accounted for most of the production. Selectively mined chrysotile asbestos ore was hand-sorted at the property and shipped to the company asbestos mill at Globe. Production also was reported by Asbestos Manufacturing Co. from the Asbestos Peak and Ash Creek mines and by Metate Asbestos Corp. from the Lucky Seven mine.

Cement.—Arizona Portland Cement Co., a division of California Portland Cement Co., and Phoenix Cement Co., a division of American Cement Corp., produced portland and masonry cements at plants in Pima and Yavapai Counties.

Clays.—Output of all types of clay sold or used increased 16 percent over that of 1962. A rise in bentonite output and additional production of miscellaneous clay by Phoenix Cement Co. accounted for most of the increased output. Miscellaneous clay was used in manufacturing building brick and portland and masonry cements; bentonite as a catalyst in oil refining; and fire clay for art pottery, flower pots, and glaze slips by the ceramic industry.

Diatomite.—Arizona Gypsum Corp. produced a small quantity of diatomaceous earth from the White Cliffs mine near Mammoth in southeastern Pinal County to be used as filler. The property, formerly operated by American Diatom, Inc., was acquired by Arizona Gypsum Corp. as the result of a merger of the two companies.

Feldspar.—Production of feldspar was reported from two mines in the State. The Taylor mine in Mohave County, operated by a contractor of International Minerals & Chemical Corp. (IMC) was the principal producer; the San Antonio Mine Co., Pima County, supplied the balance of production from the San Antonio mica mine. The bulk of the feldspar produced in Arizona was ground at the IMC mill near Kingman. Shipments of ground feldspar were made to consumers in California; some shipments were made to Colorado, Massachusetts, Ohio, Texas, Philippine Islands and Mexico. The enamel and pottery industries consumed most of the production.

Gem Stones.—Collecting gem stones continued to interest numerous individuals, societies, and dealers, who reported an estimated value of $120,000 for material gathered in 1963. Most of the activity was reported in Cochise, Greenlee, Maricopa, and Yavapai Counties. Agate, petrified wood, and turquoise were the important gem stones collected during the year.

Gypsum.—Production of crude gypsum from mines in Pinal and Yavapai Counties increased 19 percent. Four mines were operated: three in Pinal County and one in Yavapai. Arizona Gypsum Corp. operated two properties, one in Pinal County near Winkelman, and the other in Yavapai County near Camp Verde. Output from the two properties was sold uncalcined for agricultural use and/or as a cement retarder. National Gypsum Co., the largest producer, operated a mine near Winkelman and calcined much of its output for use in manufacturing wallboard and lath at the company-owned plant in Phoenix. Garcia Gypsum Co., Inc., produced crude gypsum for agricultural use. The average value of crude gypsum produced in the State during the year was $5.32 per ton, compared with $5.19 in 1962, an increase of 2.5 percent.

Lime.—Lime used in the concentration of copper ores accounted for 85 percent of all lime sold or used. Six limeburning plants were operated during the year, one each in Cochise, Greenlee, Pinal, and Yavapai Counties and two in Gila County. Natural gas was the main fuel used.

Mica.—A small quantity of scrap mica produced by Buckeye Mica Co., at its mine near Buckeye in Maricopa County, was dry ground in the company mill in Buckeye for roofing material.

Perlite.—Reaching a new high, output of crude perlite, all produced in Pinal County, increased 43 percent over that of 1962. Arizona Perlite Roofs, Inc., the largest producer, accounted for most of this increase; the balance was supplied by Harborlite Corp., the only other producer of crude. Arizona Perlite Roofs, Inc., operating the Adams and Iberri mines near Superior in Pinal County, shipped crude perlite to expanding plants in Arizona and Texas. Harborlite Corp. operated the Harborlite mine in the same general area and shipped crude perlite to a company-owned plant at Escondido, Calif. Perlite expanding plants were operated at Phoenix by Supreme Perlite, Inc., and in Tucson by Polaris Perlite Co., Inc. The expanded products were used for building plaster, loose-fill insulation, concrete aggregate, and soil conditioner.

Pumice.—Production of pumice was reported by 10 operators—including 3 individuals, 6 companies, and 1 Government agency—from deposits located in Cochise, Coconino, Graham, and Navajo Counties in 1963. Coconino County was the largest producer of pumice or pumicite materials, accounting for 89 percent of the production. Total output in the State, as measured by sales, totaled 799,869 short tons valued at $1.9 million, an increase of 6 percent in quantity and 14 percent in value over that of 1962. Arizona supplied 31 percent of the United States production, leading all other States in output of this commodity. Pumice and pumiceous materials were used mainly for railroad ballast (52 percent), concrete admixtures and aggregates (33 percent), and road construction (15 percent). The values per ton of pumice in various-use categories were concrete admixtures and

aggregate, $5.71; railroad ballast, $0.80; and road construction and other uses, $0.26. Atchison, Topeka & Santa Fe Railway Co., the principal producer of cinders, operated its Darling volcanic cinder pit near Winona in Coconino County. Other producers, in order of decreasing production, were Superlite Builders Supply Co., Coconino County; W. R. Skousen, Navajo County; Coconino County Highway Department; Standard Pozzolan Co. and Paul Zanzucchi, Coconino County; San Xavier Rock & Sand Co., Cochise County; Gila Valley Block Co., Graham County; M. E. Baker, Coconino County; and Union Carbide Nuclear Co., Graham County. Production by Union Carbide from claims in Graham County represented test material.

Pyrite.—Ray Mines Division recovered byproduct pyrite from milling copper ores at Hayden; the pyrite was used to produce sulfuric acid and sponge iron. The company also purchased a quantity of pyrite from Magma Copper Co., Magma mine, as a supplemental feed for its sulfuric-acid and sponge-iron plant. The sulfuric acid and sponge iron were used in the company copper concentrator for leaching and precipitating the copper occurring in the ore as copper oxide minerals. Pyrite produced during the year contained approximately 44 percent sulfur.

Sand and Gravel.—Sand and gravel was again the second most important mineral product of the State; the output was valued at $14.5 million. Consumption declined to 15 million tons, a 3-percent decline from the 15.6 million tons reported in 1962. Commercial production rose 3 percent because of an increased use of building sand and gravel. Government-and-contractor output decreased 10 percent because of a substantial decrease in the quantity of paving sand consumed.

TABLE 11.—Sand and gravel production in 1963, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Apache	412	$392	Navajo	113	$134
Cochise	635	573	Pima	1,653	1,620
Coconino	553	647	Pinal	1,053	786
Gila	113	154	Yavapai	685	626
Graham	39	65	Yuma	813	712
Greenlee	201	191			
Maricopa	8,607	8,424	Total	15,036	14,466
Mohave	159	142			

TABLE 12.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	1,556	$2,047	1,746	$2,265
Paving	636	655	586	613
Railroad ballast			1	1
Fill	112	81	172	112
Other	94	120	(1)	(1)
Industrial:				
Blast	1	3	1	5
Oil (hydrafrac)	19	206	14	157
Other	32	58	4	24
Total	2,450	3,170	2,524	3,177
Gravel:				
Construction:				
Building	1,984	2,366	2,182	2,247
Paving	2,735	2,521	1,696	1,690
Railroad ballast	(1)	(1)	(1)	(1)
Fill	458	322	637	526
Other	142	105		
Miscellaneous	128	156	1,079	1,091
Total	5,447	5,470	5,594	5,554
Total sand and gravel	7,897	8,640	8,118	8,731
Government-and-contractor operations:				
Sand:				
Building	151	151	7	7
Paving	2,028	3,694	846	554
Fill	143	48	22	13
Total	2,322	3,893	875	574
Gravel:				
Building	207	205	17	17
Paving	5,090	4,636	6,026	5,144
Fill	18	5		
Other	45	25		
Total	5,360	4,871	6,043	5,161
Total sand and gravel	7,682	8,764	6,918	5,735
All operations:				
Sand	4,772	7,063	3,399	3,751
Gravel	10,807	10,341	11,637	10,715
Total	15,579	17,404	15,036	14,466

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Fill."

Stone.—Production of stone declined from 4.3 million tons valued at $6.6 million in 1962, to 3.3 million tons valued at $5.1 million. A lower demand for road material and cement was the primary reason for the 25-percent decrease in output. Basalt, granite, limestone, marble, sandstone, and miscellaneous stones were quarried in 13 counties in Arizona. Only Santa Cruz County, in the extreme southern part of the State, did not report production. Crushed stone accounted for more than 99 percent of the total production. Crushed limestone, produced in six counties, accounted for 54 percent of the total quantity of stone produced and 46 percent of the total value. The largest output came from Pima and Yavapai Counties; Cochise, Gila, Greenlee, and Pinal Counties furnished the balance. Major

producers included Arizona Portland Cement Co., Phoenix Cement Co., Paul Lime Plant, Inc., and Phelps Dodge Corp. Eighty-six percent of the total production was used in manufacturing cement and lime. Crushed limestone was also used as a flux in smelting copper ores and concentrates and as road material. Crushed sandstone was quarried mainly in Cochise, Coconino, and Gila Counties, for use as concrete and roadstone and as a flux in smelting copper ores. A small quantity was used in manufacturing abrasives, cleansers, enamel, porcelains, pottery, and tile. Contractors for the Federal Bureau of Public Roads accounted for 57 percent of the total production. Crushed miscellaneous stone, quarried in 13 counties, accounted for 20 percent of the total stone output, all used in road construction.

TABLE 13.—Stone production in 1963, by counties

County	Short tons	Value	County	Short tons	Value
Apache	18,713	$117,592	Navajo	(1)	(1)
Cochise	410,072	1,006,228	Pima	747,743	$861,898
Coconino	281,661	450,325	Pinal	89,100	169,165
Gila	373,104	536,504	Yavapai	525,802	637,986
Graham	(1)	(1)	Yuma	19,588	172,822
Greenlee	(1)	(1)	Undistributed	190,614	341,281
Maricopa	586,337	586,753			
Mohave	13,881	188,596	Total	3,256,615	5,069,150

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 14.—Stone sold or used by producers, by kinds

Year	Basalt and related rocks (traprock)		Granite		Limestone		Marble	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1959	(1)	(1)	87,968	$58,762	1,345,200	$1,678,900	(1)	(1)
1960	647,441	$651,845	(1)	(1)	1,782,967	2,079,263	(1)	(1)
1961	285,371	285,850	7,155	7,155	2,099,455	2,458,371	4,513	$60,732
1962	586,323	879,482	113,274	117,424	1,986,091	2,430,203	12,528	104,929
1963	80,816	208,716	20,705	32,738	1,771,114	2,307,107	22,713	287,042

Year	Sandstone		Slate		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1959	238,101	$820,146	----------	----------	796,416	$1,440,647	2,467,685	$3,998,455
1960	490,339	1,175,090	----------	----------	1,328,560	1,200,710	4,249,307	5,106,908
1961	334,557	942,155	----------	----------	851,276	872,217	3,582,327	4,626,480
1962	601,532	1,486,902	84	$837	1,033,310	1,596,130	4,333,142	6,615,907
1963	714,897	1,574,782	----------	----------	646,370	658,765	3,256,615	5,069,150

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other stone."

TABLE 15.—Stone sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction short tons	412	$7,315	3,309	$37,288
Rubble do	356	4,991	1,767	14,296
Rough architectural cubic feet	[1] 15,867	9,245	[2] 2,510	2,545
Dressed architectural do	[3] 267	641	[4] 8,776	17,541
Flagging do	[5] 100,318	77,079	[6] 67,412	58,416
Total (approximate, in short tons)	9,527	99,271	11,015	130,086
Crushed and broken stone:				
Riprap short tons	99,843	110,261	14,128	35,848
Metallurgical do	510,532	1,094,554	496,504	947,990
Concrete and roadstone do	1,971,099	3,042,468	1,172,851	1,568,326
Other do	[7] 1,742,141	[7] 2,269,353	[8] 1,562,117	[8] 2,386,900
Total do	4,323,615	6,516,636	3,245,600	4,939,064
Total stone (approximate, in short tons)	4,333,142	6,615,907	3,256,615	5,069,150

[1] Approximately 1,215 short tons.
[2] Approximately 213 short tons.
[3] Approximately 20 short tons.
[4] Approximately 670 short tons.
[5] Approximately 7,524 short tons.
[6] Approximately 5,056 short tons.
[7] Includes stone used in abrasives, cement, enamel, lime, ornamental aggregate, pool mix, porcelain, pottery, roofing granules, stucco, terrazzo, and tile.
[8] Includes stone used in abrasives, cement, cleansers, enamel, landscaping, lime, porcelain, pottery, roofing granules, terrazzo, tile, and unspecified use.

Vermiculite.—At its Glendale exfoliating plant at Glendale in Maricopa County, Ari-Zonolite Co. produced exfoliated vermiculite from crude ores obtained from mines in Montana. Output was 33 percent above that of 1962. The exfoliated product was used as lightweight aggregate in concrete and plaster, insulation, and in agricultural and acoustical products.

MINERAL FUELS

Coal (Bituminous).—Lawrence Isaac Coal Co. produced less than 1,000 tons of coal from the Black Mesa coal seam of the Cow Springs No. 3 mine near Tona Lea, Coconino County. Production of 1,000 tons or less is not reported in table 1.

Helium.—The Arizona Oil and Gas Conservation Commission reported that 438.5 million cubic feet of helium-bearing gas was produced from wells in the Pinta Dome field, Apache County. The gas contained approximately 8.5 percent helium, or 37.3 million cubic feet. Assuming that 97 percent of the contained helium was recovered at the Navajo processing plant in Apache County, the output of Grade A helium was approximately 36.2 million cubic feet. Based on the value of $35 per 1,000 cubic feet of helium, established by the Federal Bureau of Mines for sales of Government-produced helium to Government and industrial consumers, the value of output would be $1.3 million.

Ram Oil Co., Phoenix, received approval from the Arizona Corporation Commission to construct a $1.75 million pipeline and gathering system to transport helium, nitrogen, and helium-bearing gas in Apache, Navajo, and Coconino Counties. The proposed pipeline was to connect 20 helium-bearing gas wells in the area with a proposed $4

million 400,000-cubic-foot-per-day extraction plant 40 miles east of Holbrook. Geologists estimated that the three-county area had a 50-billion-cubic-foot helium potential.

TABLE 16.—Wildcat- and development-well completions in 1963, by counties

County	Oil	Gas	Dry	Total	Footage
Wildcat:					
Apache	1	1	5	7	34,600
Cochise			2	2	6,000
Coconino			1	1	1,100
Navajo			5	5	5,400
Total	1	1	13	15	47,100
Development: Apache		1		1	1,200
Total all drilling	1	2	13	16	48,300

Source: Oil and Gas Journal.

Eastern Petroleum Co. of Carmi, Ill., announced plans for a 16-well drilling program in the Navajo Springs area, Apache County. Drilling of the 16 wells on a 70,000-acre block northeast of the Pinta Dome helium area was to be completed early in 1964.

Petroleum and Natural Gas.—Output of crude petroleum in Arizona increased 41 percent in quantity over that of the preceding year. All production in the State came from wells in Apache County. Sixteen wells were completed during the year, compared with 54 in 1962. The activity, including 1 development and 15 exploratory wells, resulted in 1 oil and 2 gas discoveries. Exploration by Texaco Inc., in the Paradox-Black Basin area in northern Apache County, resulted in the one oil discovery. In another development, Pan American Petroleum Corp. completed a 1.5 mile south extension to Bita Peak field.

Apache County accounted for 8 of the 16 completions, 7 exploratory and 1 development. The remaining 8 exploratory wells included 5 wells in Navajo County, 2 in Cochise, and 1 in Coconino. Total drilling in the State included 47,100 feet of exploration and 1,200 feet of development drilling for a cumulative total of 48,300 feet.

REVIEW BY COUNTIES

Apache.—The county was the second largest producer of uranium ore in the State, accounting for 34 percent of the State total production. The U_3O_8 content of the 51,622 tons of ore shipped from 29 operations ranged from 0.07 to 0.34 percent, averaging 0.22 percent on a weighted basis. The f.o.b. mine value of the ore ranged from $1.96 per ton to $29.30 per ton, averaging $18.32 per ton. Total value of uranium ore shipments f.o.b. mine was $945,819. Principal producers of ore were Kerr-McGee Oil Industries, Inc., at the Mesa Group mines and VCA at Monument No. 2 mine. Other producers operating in the county were Climax Uranium Co. (Frank No. 1), Robert Goode (Cisco No. 3), James W. Hall (Nakai Chee Begay and Tom Joe No. 6 mines), and W. D. Tripp Mining Co. (Upper Canyon). The quantity of vanadium recovered from Apache County uranium

ores, processed in Colorado and New Mexico uranium mills equipped with vanadium recovery units, was below that of 1962.

TABLE 17.—Value of mineral production in Arizona, by counties

County	1962	1963	Minerals produced in 1963 in order of value
Apache	[1] $7,349,518	[2] $4,035,359	Helium, uranium ore, vanadium, sand and gravel, clays, natural gas, petroleum, stone.
Cochise	51,289,505	49,409,582	Copper, gold, stone, silver, lime, sand and gravel, zinc, pumice, gem stones, lead.
Coconino	3,987,166	6,160,997	Uranium ore, pumice, sand and gravel, stone, copper, silver, gem stones.
Gila	52,827,599	58,632,863	Copper, lime, molybdenum, asbestos, stone, silver, sand and gravel, gold, gem stones, iron ore, mercury, clays.
Graham	255,840	94,926	Sand and gravel, pumice, stone, gem stones, silver, copper.
Greenlee	78,150,348	77,360,587	Copper, lime, silver, gold, molybdenum, stone, sand and gravel, gem stones.
Maricopa	6,946,540	9,139,113	Sand and gravel, stone, mica (scrap), clays, mercury, gem stones, silver, gold, copper, lead.
Mohave	576,745	[3]	Stone, sand and gravel, feldspar, gem stones, gold, silver.
Navajo	3,638,234	1,403,772	Uranium ore, copper, sand and gravel, stone, pumice, silver, gem stones, vanadium, zinc.
Pima	127,418,897	131,656,225	Copper, cement, silver, molybdenum, sand and gravel, gold, stone, zinc, clays, lead, gem stones, feldspar.
Pinal	110,131,864	111,220,356	Copper, molybdenum, silver, gold, sand and gravel, gypsum, lime, perlite, pyrites, stone, iron ore, diatomite, gem stones, lead, zinc.
Santa Cruz	530,975	203,138	Zinc, lead, silver, copper, gold.
Yavapai	29,095,274	30,788,349	Copper, cement, zinc, lead, silver, stone, gold, sand and gravel, lime, molybdenum, gypsum, clays, gem stones.
Yuma	1,080,304	901,902	Sand and gravel, stone, gem stones, copper, gold, silver.
Undistributed [4]	[1] 852,314	384,821	
Total	[1] 474,131,000	481,392,000	

[1] Revised figure.
[2] Petroleum value is preliminary.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Includes some stone (1962), sand and gravel (1962), gem stones, and tungsten ore and concentrate (1962) that cannot be assigned to specific counties and values indicated by footnote 3.

Petroleum production from nine wells in the East Boundary Butte, East Boundary Butte No. 8, North Toh-Atin, Twin Falls Creek, Walker Creek, and Dry Mesa fields, and an undesignated field was 41 percent higher in quantity and value compared with 1962. Eight of the 16 new wells drilled in Arizona were in Apache County; 1 development gas well, 1 exploration gas well, and 1 exploration oil well were successful. Drilling in the county totaled 35,800 feet; 34,600 feet of exploration and 1,200 feet of development drilling. Texaco Inc. completed a McCracken (Devonian) discovery that pointed up the possibilities of the Paradox-Black Mesa area. The discovery, No. 1 Navajo-AG, NW¼ SE¼ sec 16, T 41 N, R 25 E, completed before midyear pumped 182 barrels of oil with 5 barrels of water per day from perforations 6,370–6,384 feet in pre-Pennsylvanian formations. The Walker Creek field discovery was 5 miles from the closest drilling, 6 miles south of Pennsylvanian production at Shenle Wash in Utah and 16 miles west of the nearest Pennsylvanian production in Arizona. In another development, Pan American Petroleum Corp. completed a 1.5-mile extension to Bita Peak field. The new well, No. 1 Navajo–O, located in the SE¼ SW¼ sec 23, T 41 N, R 30 E, flowed 4.6 million cubic feet of gas per day on ¾-inch choke. The well went to a total

depth of 6,805 feet in pre-Cambrian but had only slight shows in the formation below the Ismay.

Sand and gravel production was 57 percent below the 1962 output. The two commercial producers, Arizona Silica Sand Co. and Joseph C. Hastings, produced 34,600 tons of sand and gravel used for building construction, oil fracturing, and other industrial uses. Contractors of the Federal Bureau of Indian Affairs produced 377,500 tons of paving sand and gravel for highway construction.

A contractor of the Federal Bureau of Indian Affairs produced 17,000 tons of crushed basalt and 1,713 tons of crushed miscellaneous stone for use in highway construction.

Filtrol Corp. mined and sold bentonite clay from the Cheto open-pit mine near Sanders for use as a petroleum catalyst.

Cochise.—Production of copper and associated gold and silver constituted the principal mineral activity in the county. The combined value of copper, gold, and silver production was $46.8 million (95 percent) of mineral output, most of which came from the Copper Queen and Lavender mines operated by the Copper Queen Branch, Phelps Dodge Corp. The county ranked first in the State in the production of gold, fourth in the production of silver, and fifth in the production of copper. Lead and zinc production accounted for less than one quarter of 1 percent of the total value of mineral production. The R. L. Brown tungsten property was inactive during the year.

Copper Queen Branch, Phelps Dodge Corp., the third largest copper producer in the State, was ranked first in the production of gold and third in the production of silver. According to the company annual report for 1963, 715,000 tons of copper ore was produced from the Copper Queen undergound mines and 5.3 million tons from the Lavender pit at Bisbee. In addition, 15.8 million tons of waste and leach material was mined from the Lavender pit. The ratio of waste and leach material to ore mined in 1963 was 2.95 : 1, compared with 2.62 : 1 in 1962. Part of the ore from the Copper Queen mine was shipped to the company smelter at Douglas; 398,000 tons was treated at the Lavender pit concentrator. The concentrator treated an average of 19,386 tons of ore per operating day. Output of copper at the Douglas smelter from ores obtained from the underground mines totaled 33,071 tons; from open pit ores 38,266 tons. In September, a new reverberatory furnace equipped with wasteheat boilers was completed and placed in operation to improve plant efficiency.

Johnson Camp mine, near Willcox, was the second largest producer of copper and the principal producer of zinc in the county. McFarland & Hullinger, the principal producer of zinc, ceased operations in mid-January at the mines of Cyprus Mines Corp., at Johnson Camp. Concentrates from the Johnson Camp mine were shipped to copper and zinc smelters at Douglas, El Paso (Tex.), and Bartlesville (Okla.). From the Burro claims, a part of the Johnson Camp, Strong & Harris, Inc., mined siliceous flux ore containing copper. According to the annual report of Cyprus Mines Corp., field work was continued at the Johnson Camp properties to determine the feasibility of acid leaching a large tonnage of low-grade copper oxide ores.

Small quantities of gold, silver, copper, lead, and zinc were recovered from several small properties. Sierra Vista Mining Co. pro-

duced a small quantity of gold, silver, copper, lead, and zinc from lead ore obtained from the Emerald mine in the Hartford mining district. The King of Lead mine in the Dos Cabezas mining district. operated by J. A. & N. A. Pursley, was the largest producer of lead in the county.

New developments in the county included the start of leach operations at the Mame mine in the Turquoise mining district by the Interstate Accounting and Office Service of Phoenix.

Nonmetals production, valued at $2.5 million, accounted for 5 percent of the total value of mineral output, a decrease of 2 percent ($50,793). The drop in value resulted from a decline in lime and stone production. Gem stones, lime, pumice, sand and gravel, and stone were the principal nonmetals produced. Limestone, produced by Paul Lime Plant, Inc., was used primarily for the manufacture of lime by the company at the Paul Lime plant and as a flux in the smelting of copper ores. Sandstone, quarried at the Gilbert silica pit by Andrew J. Gilbert Construction Co., was used as a smelter flux. A small quantity of varied colored marble, quarried by Dragoon Marble Quarries, Inc., was used in the manufacture of terrazzo and plaster sand.

Coconino.—In 1963 Coconino County ranked first in the State in the value of uranium-ore production. This value constituted 48 percent of the total value of mineral production. Uranium ore from three operations was processed at the El Paso Natural Gas Co. mill at Tuba City and at the Atlas Minerals Mill at Mexican Hat, Utah. The Orphan mine operated by Western Equities, Inc., was the principal producer, followed in order by the Jack Daniels No. 5 operated by Page P. Blakemore, and the Julius Chee No. 3 operated by Leon Sterling, Jr. Shipments of uranium ore from the three properties totaled 62,097 short tons valued at $2.9 million. The average grade of ore shipped from the mines contained 0.53 percent uranium oxide. The large increase in both quantity and value of uranium mine shipments resulted from the increased production of high-grade ores from the Orphan mine.

Gem stones, pumice, sand and gravel, and stone produced in the county had a combined value of $2.9 million and supplied 46 percent of the total value of mineral output in the county. Pumice and pumicite material quarried by Atchison, Topeka & Santa Fe Railway Co., M. E. Baker, Coconino County Highway Department, Standard Pozzolan Co., Superlite Builders Supply Co., and Paul Zanzucchi, from Winona and Flagstaff deposits, was valued at $1.8 million. Contractors for the Federal Bureau of Public Roads, the Federal Forest Service, and the Arizona State Highway Department supplied most of the sand and gravel and stone produced in the county. Dimension sandstone from quarries around Ashfork, Drake, and Williams was used as building stone and flagging by the construction industry.

Lawrence Isaac Coal Co. produced a small quantity of coal from the Black Mesa coal seam at the Cow Spring No. 3 mine; all was sold on the open market.

Silver and copper were recovered from uranium ores produced by Western Equities, Inc., at the Orphan mine and by three operators from copper ores produced at mines in the Grand Canyon and Jacob

Canyon-Warm Springs mining districts. Zontelli Western Mining Co., Ironton, Minn., began shipments of copper precipitates from a newly constructed copper precipitation plant at the old Mardun copper deposit in the White Mesa mining district of the Navajo Indian Reservation.

Gila.—Four of the 12 commodities produced in the county accounted for 98 percent of the total value of mineral production. Copper, lime, molybdenum, and asbestos were the principal commodities produced.

According to the Inspiration Consolidated Copper Co. annual report, copper output was in close balance with deliveries. The Inspiration Division mined and treated ore at 90 percent of capacity during the first 9 months and at a capacity level during the remainder of the year. Improved demand and failure of the Christmas Division to reach capacity because of unforeseen mining difficulties were the primary reasons given for the increasing output by the Inspiration Division. The mining of an ore having a lower copper content also stimulated the necessity of increasing production. The Inspiration Division Inspiration mine (Live Oak and Thornton pits) increased production from 15,000 tons per day to maximum capacity levels of 16,500 tons per day during the 4th quarter. The division mined 5.5 million tons of ore containing 0.925 percent total copper (0.416 percent oxide copper and 0.509 percent sulfide copper), indicating that the ore was slightly lower in grade than that of 1962. Preparatory to mining, the increased stripping to ore ratios reported by the company (1.09:1 in 1963 to 0.71:1 in 1962) reflected removal of 2.8 million tons of waste material from the west extension of the Thornton pit. About 21.9 million tons of waste must be removed before the ore in this area becomes available in significant quantity. Stripping ratios were expected to increase during 1964 and 1965 as work continued in preparation for future 20,000-ton-per-day operations, but will then decline. The larger daily tonnage was tending to offset lower copper content of ore, thus maintaining copper output at approximately the current rate. Stripping of waste at the Red Hill mine was to begin upon completion of stripping at the west extension of the Thornton pit. A total of 88 million pounds of copper was produced from Inspiration ores, or approximately 16.03 pounds of copper per ton of ore produced. Production of copper by leaching in place accounted for an additional 5.9 million pounds of copper (5.2 million pounds in 1962), raising the total copper output to 93.9 million pounds. The approximate 740,000-pound increase of copper by leaching in place resulted from preparing and placing in operation a new dump in December 1962; the new area was to replace old leaching sites showing signs of exhaustion. The smelter treated 164,680 tons of new copper-bearing material, one third of which was either purchased or treated on toll. Facilities were completed early in the year for unloading, blending, and storing incoming concentrates, precipitates, and ores and delivering them to smelting furnaces. A $250,000 new converter was to be installed in 1964. Capacity of the metallurgical plant was expected to increase from 16,500 to 20,000 tons of ore per day to offset lower copper content of the ore and to maintain copper output at approximately the current rate.

The Christmas mine, scheduled to produce 4,000 tons per day by mid-1963, failed to reach capacity because of difficulties encountered with unstable ground conditions. Daily output, which reached a low in September, had been rising and was running about 3,000 tons per day, 75 percent of capacity at yearend. During the year the Christmas mine produced and treated 638,755 tons of ore containing 1.681 percent copper. Overall recovery from the ore was 89.48 percent or 20,232,893 pounds of copper. Mining had confirmed ore grades indicated by original diamond drilling, although actual grade of ore mined had been below the average grade of ore reserves. The lower grade was caused in part by the necessity of mining close to or in the footwall or hanging wall for development and in part by mining beyond the original ore limits set by diamond drilling, to determine the ultimate ore-grade limits. According to company engineers, proved ore reserves in the Live Oak, Thornton, and Red Hill open-pit mines contained approximately 1,043,000,000 pounds of recoverable copper. The proved and probable ore reserves in the Christmas mine totaled 637,000,000 pounds of recoverable copper.

Molybdenum concentrates recovered during the year contained 473,598 pounds of molybdenum.

Miami Copper Co., organized in 1908 and acquired by Tennessee Corp. in 1960, was operated as a division of Tennessee Corp. until June of 1963 when Tennessee Corp. merged with Cities Service Co. The company recovered copper from its ore mining, milling, and leaching operations at Copper Cities, from ore leached in place at the Miami underground mine, and leached in dumps at the Castle Dome property. The company recovered copper from the leaching of stripping dumps at Copper Cities for the first time in 1963.

Six other mines yielded ore from which copper, gold, or silver was recovered. Mercury output came from cleanup operations of Gordon K. Grimes at the Gold Creek mill.

Asbestos was produced from the Regal and Chrysotile mines by Jaquays Mining Corp., from the Asbestos Peak and Ash Creek mines by Asbestos Manufacturing Co., and from the Lucky Seven mine by Metate Asbestos Corp. A small quantity of stockpiled asbestos ore from the Phillips mines was processed and shipped.

Fire clay was mined from the Weary open pit by Gila Arts Co. for use by the ceramics industry in manufacturing art pottery, flower pots, and glaze slip.

Output from limestone quarries and crushing plants, operated at two sites, was sold or used for manufacturing lime, for use as a flux in smelting of copper ores, and as a road material. Production came from quarries operated by Hoopes & Co. and Ray Mines Division. Basalt produced by Gil Brown Constructors, a contractor for the Federal Bureau of Public Roads and the San Carlos Indian Reservation, was used in concrete and as riprap and roadstone.

H. M. Seitz mined a small quantity of magnetite ore from the Margaret Howard mine for use as a processing agent.

Sand and gravel was produced in the county by the Arizona State Highway Department and the Gila County Highway Department for paving.

Graham.—Nonmetals accounted for more than 99 percent of all minerals produced. Sand and gravel produced by the Arizona State Highway Department, Gila Valley Concrete, Inc., and W. A. Morris Sand and Gravel Co. accounted for 68 percent of the total production. Gila Valley Block Co., operating the Pumice Nos. 1 and 2 and Bluebird mines, produced volcanic cinders and pumice for use in manufacturing concrete blocks and Union Carbide Nuclear Co., developing the E–Z claims, shipped a small quantity of pumice for testing purposes. Metals output, copper and silver, came from silver ore from the Bobbie Dean mine operated by Jack Darland.

Properties of the Athletic Mining Co., including patented and unpatented claims, mill site and milling facilities and all buildings located on their property in the Aravaipa area, were purchased by American Zinc, Lead and Smelting Co. on July 31. The property was closed several years ago as a result of low metal prices.

Greenlee.—The Morenci open-pit mine—operated by the Morenci Branch, Phelps Dodge Corp., the largest producer of copper in the State and the second largest in the Nation—contributed the major portion of the county total value of mineral output. According to the company annual report, of the 45.1 million tons of material handled, 17.1 million tons was ore. The ratio of waste and leached material to ore mined at the Morenci open pit was 1.63:1, compared with 1.56:1 in 1962. The concentrator treated 17.1 million tons of ore during the year at an average daily rate of 57,246 tons, an increase of 2,160 tons per day over that of 1962. Two newly installed grinding mills that went into operation in July were instrumental in increasing the capacity: Rated capacity of the concentrator was increased 7 percent, from 55,000 to 59,000 tons per day. Output of copper at the smelter totaled 121,220 tons.

Construction of Blue Ridge Dam project on East Clear Creek, a tributary of Little Colorado River in central Arizona, was started in May. Pouring of concrete at the 150-foot high arch-dam structure was completed, and work has begun on the 8.5 mile tunnel to deliver water impounded behind the dam into the East Verde River in exchange for water to be diverted from Black River for use in Morenci operations. Development and testing of a leach-precipitation-flotation (LPF) process for recovering the nonsulfide copper in Morenci ores was continued. Tests completed by early 1963 indicated that the technically and economically feasible process could result in increasing copper recoveries by 7 to 8 percent. By the end of the year construction was well under way on an acid plant, a concentrate roasting plant, a precipitant-manufacturing plant, additional limeplant capacity, and additions and alterations to the powerplant. Research on Morenci ores included studies on the application of X-ray analysis to the continuous assaying of flotation feeds and tailing streams in the concentrator. The Morenci mine was the fifth largest producer of molybdenum in Arizona, the fourth largest producer of silver, and the fifth largest producer of gold—all three metals recovered as byproducts from treating copper ores. The company operated a limekiln at the property to provide quicklime for metallurgical purposes.

Nonmetals accounted for only 2 percent of total value of mineral production in the county. Contractors for the Arizona State Highway Department and crews of the Greenlee County Highway Department furnished the entire production of paving sand and gravel. Phelps Dodge Corp. produced crushed limestone and crushed sandstone from quarries near Morenci for use in milling and smelting copper ore. A small quantity of miscellaneous stone produced by contractors for the Arizona State Highway Department, was crushed and used for concrete and roadstone. Gem or ornamental stones valued at $12,543 were collected by amateur collectors and gem dealers.

Maricopa.—The mineral industry of Maricopa County centered around construction: The value of sand and gravel output, $8.4 million, represented 92 percent of the total value of mineral production in the county. Output increased 27 percent in quantity and 24 percent in value. Of the 11 commercial producers, Arizona Sand and Rock Co., Union Rock & Materials Corp., and United Materials, Inc., were the major producers. Government-and-contractor production totaled 2.1 million tons valued at $1.9 million. Five hundred and eighty-six thousand tons of crushed granite, crushed and dimension miscellaneous stones, dimension marble and crushed sandstone—valued at $586,753—was quarried in the county. Scrap mica produced at the Buckeye mine by Buckeye Mica Co. was ground at the company mill near Buckeye for use as roofing material. Phoenix Brick Yard and Wallapai Brick & Clay Products, Inc., mined and processed miscellaneous clay from company-owned pits near Phoenix for use in manufacturing building brick. Big Sam Mines, Inc., furnaced ores obtained from the National mine for producing mercury. Crude ore obtained from the Iberri perlite mine in Pinal County was expanded by Supreme Perlite, Inc., for use in manufacturing building plaster and as loose-fill insulation, concrete aggregate, and a soil-conditioning agent. Small quantities of gold, silver, copper, and lead were produced from four small operations in the county.

Mohave.—Contractors for the Arizona State Highway Department and the Federal Bureau of Public Roads furnished the entire production of 159,000 tons of paving sand and gravel valued at $142,000. Crushed sandstone, obtained from the Pancho, Taylor, and White Spar quarries, was sold or used by G. R. Haynes, IMC, and C. F. Weeks. The material was used in manufacturing abrasives, cleansers, enamels, pottery, porcelain, and tile. A small quantity of miscellaneous stone was mined by Isbell Construction Co. and Sam Bowman for road and building construction. IMC continued operating its feldspar mill at Kingman; shipments of ground feldspar went to consumers in California, Colorado, Massachusetts, Ohio, Texas, Mexico, and the Philippine Islands. Ore for the grinding plant was obtained from the company Taylor mine near Kingman. Miscellaneous clay and shale mined by Grabe Brick Co., Inc., Phoenix Brick Yard, and Tucson Pressed Brick Co., Inc., was used in manufacturing building brick. Gem and ornamental stones valued at $5,000 were collected by collectors and hobbyists.

A small quantity of gold and silver was obtained from three lode operations and one placer operation. Development at the Duval Corp. Mineral Park copper-molybdenum property near Kingman and the

construction of mill and auxiliary facilities were well advanced by yearend.

Navajo.—Uranium ore, the most valuable mineral commodity produced, accounted for more than 68 percent of the total value of mineral production in the county. Six operations furnished 24 percent of the State production of uranium ore. The U_3O_8 content of the ores mined ranged from 0.13 to 0.39 percent, averaging 0.30 percent. The f.o.b. mine values ranged from $6.76 for 0.13-percent material to $34.05 for 0.39-percent material. The total value received for the 223,283 pounds of contained uranium oxide in the 36,865 tons of ore shipped was $957,495, equal to $25.97 per ton. The largest producer, Industrial Uranium Co., operating the East Starlight, Moonlight, and Sunlight South mines, shipped its entire production to mills operated by Climax Uranium Co. at Grand Junction, Colo., and Atlas Minerals, Mexican Hat, Utah. Additional ore from the Big Four No. 2 mine operated by Fritz-Erickson Mining Co. was processed at the Utah mill. Vanadium recovered from Navajo County uranium ores, processed in Colorado uranium mills equipped with vanadium recovery circuits, was substantially less than that of 1962. Sand and gravel produced by Ray Despain, Reidhead Sand & Rock, Inc., and contractors and crews of the Arizona State Highway Department, Navajo County Highway Department, and the city of Winslow totaled 113,000 tons of building and paving sand and gravel, fill sand, and miscellaneous gravel. A small quantity of dimension sandstone was quarried by Roy Reidhead and crushed miscellaneous stone by contractors for the Arizona State Highway Department.

Pima.—Because of increased production of copper from the Daisy and Mission mines, the value of mineral production in Pima County increased from $127.4 million in 1962 to $131.7 million in 1963. Copper furnished 87 percent of the total value of mineral production. Five mines—Daisy, Esperanza, Mission, New Cornelia, and Silver Bell—furnished 93 percent of the copper produced in the county and 26 percent of that produced in the State.

According to the Phelps Dodge Corp. annual report, the New Cornelia Branch moved 26.1 million tons of material from the New Cornelia mine near Ajo; 9.4 million tons was ore and 16.7 million tons was waste. The ratio of waste to ore mined in the Ajo open pit was 1.78:1 compared with 1.54:1 in 1962. The concentrator treated 9.4 million tons of ore during the year—an average rate of 31,264 tons per day. The smelter recovered 67,206 tons of copper compared with 71,008 tons in 1962. Major items of equipment received during the year were eight 2,250-horsepower diesel-electric locomotives ordered in 1962. Locomotives replaced the trolley-electric locomotives.

According to the Asarco annual report, 7.3 million tons of ore was treated and 172,500 tons of concentrate, containing 50,476 tons of copper, was recovered at the Mission mine and mill. The total quantity of ore and waste removed from the pit was 33.5 million tons. At the Silver Bell mine, the fifth grinding section in the mill was completed in February and operated throughout the rest of the year. Treated at the mill was 2.9 million tons of ore from which 21,563 tons of copper was produced. An additional 2,026 tons of copper was recovered as precipitates from dump-leaching operations.

Cyprus Mines Corp., manager and owner of 50 percent of Pima Mining Co., reported that 2 million tons of ore averaging 1.34 percent copper was mined to recover 92,000 tons of concentrate. In 1962, Pima mined and milled 1.5 million tons of 1.54 percent copper ore from which 79,000 tons of concentrate was produced. The enlargement of the mill to a capacity of 7,000 tons of ore per day was completed in August 1963, 6 weeks ahead of schedule. The expansion program was designed for mining and milling the reserves in the pit more rapidly and efficiently, and for treating an adjacent large deposit of lower grade ore. Performance of the enlarged mining and milling operation exceeded expectations. Drilling indicated additional ore including some low-grade material surrounding the northeast ore zone and high-grade ore beneath the present pit. Studies were being made to determine the economics of developing these deposits.

According to the Duval Corp. annual report to stockholders, the Esperanza open pit near Tucson yielded 46.8 million pounds of copper in 1963, an increase of 837,283 pounds from 1962. Because of a slight decrease in the grade of ore milled, less copper was produced by milling operations. This reduction was more than offset by an increase in the production from leach-precipitation operations. Molybdenum production totaled 1.1 million pounds, 108,137 pounds less than that of 1962. Lower output resulted from a reduction in mineral content of the mill feed. The milling rate increased from an average of 11,315 tons per day in 1962 to 11,568 tons. Unit costs and total production cost compared favorably with those of 1962.

Reporting on the Daisy mine, Banner Mining Co. stated that Pima Mining Co. continued producing ore from Banner ground during 1963. Banner reported that Pima produced 257,195 tons of ore from the Daisy mine, slightly more than specified under the 1959 agreement. Because the ground on which Pima has a custom mining and milling agreement was not included in the Banner-Anaconda agreement, Banner will continue to receive proceeds for an equal amount of copper annually through 1968. Banner also reported that Pima had excavated 1.5 million tons of oxidized material, containing about 1 percent copper, from the volume under contract. Stockpiled low-grade sulfides from the upper cone volume of the Daisy mine under contract with Pima totaled 119,564 tons.

On May 27, the Banner Mining Co. Palo Verde mine was closed by a strike called by the International Union of Mine, Mill, & Smelter Workers. Production at this property from January 1 to June 1 totaled 64,298 tons of ore, which when milled at the Mineral Hill mill produced 5,866 tons of concentrate. Development work by the company included 1,126 feet of crosscutting and drifting. In addition, 3,530 feet of long-hole drilling was completed. Since the closing of the mine on May 27, most of the equipment had been removed to prevent rusting and deterioration. Mine rails and air and water lines were left intact.

Other metals produced in the county included gold, lead, molybdenum, silver, and zinc. Most of the gold and silver was recovered as a byproduct of copper refining. The Atlas mine, operated by B S & K Mining Co., was the largest producer of lead and zinc.

All molybdenum production came from the Esperanza mine operated by Duval Corp. and from the Silver Bell mine operated by Asarco.

Nonmetal commodities were produced primarily for use in the construction industry. Stone from 14 quarries in the county totaled 747,743 tons valued at $861,000. Limestone, the principal stone produced, was quarried by Arizona Portland Cement Co. for use in manufacturing portland and masonry cements at the company mill near Rillito. A small quantity of marble was quarried and processed by Andrada Marble Co. and Snotop Minerals, Inc., for use as roofing granules and in landscaping; Everett A. Sewell quarried dimension marble for use as decorative-building stone. Crushed sandstone from the Little Chief, San Antonio, and U.S. Silica quarries was sold by Virgil Denning, San Antonio Mine Co., and Jack Worsham & Henry Jarvis, respectively, for use as smelter flux. Manufacture of building brick furnished an outlet for the entire production of miscellaneous clay. Leading producers of clay in order of output were Grabe Brick Co., Inc., Tucson Pressed Brick Corp., and Phoenix Brick Yard. Twelve commercial operators produced 847,300 tons of sand and gravel used for building, paving, fill, railroad ballast, and miscellaneous uses. Contractors for the Arizona State Highway Department and contractors and crews of Pima County Highway Department accounted for 805,200 tons of sand and gravel used in highway construction.

Pinal.—One quarter of the Arizona copper production was obtained from ores from eight mines in the county. Output of copper was slightly below 1962 production, because output from the Ray pit and Magma mine declined. Copper supplied $102.7 million (92 percent) of the $111.2 million value of mineral production in the county. Gold and silver valued at $2.1 million—recovered primarily as byproducts from copper ore—accounted for 2 percent of total value of mineral production. Nonmetals produced were diatomite, gem stones, gypsum, lime, perlite, pyrites, sand and gravel, and stone.

According to the annual report of the Magma Copper Co., San Manuel Division produced 12,555,000 tons of ore in 1963, assayed at 0.795 percent sulfide copper, compared with 12,565,545 tons of ore assayed at 0.748 percent in 1962. The tonnage of ore mined per operating day was 35,139 tons, compared with 35,165 tons in 1962. During the year, 12,482,145 tons of ore was treated at an average rate of 34,935 tons per day. Approximately 84 percent of the total copper and 90 percent of the sulfide copper were recovered. Copper recovery per ton of ore mined in 1963 was 14.11 pounds compared with 13.40 in 1962. A total of 306,752 tons of copper concentrate was processed at the smelter compared with 303,223 tons in 1962. Tons smelted per operating day averaged 872 in 1963 and 857 in 1962. Metal production was 88,536 tons of copper, 4,735,771 pounds of molybdenum sulfide, 18,760 ounces of gold, and 310,228 ounces of silver. The increased production of copper (8,656,274 pounds) over 1962 production was due to an increase in the copper content of the ore mined. The San Manuel quarry delivered 63,681 tons of limestone and 17,443 tons of quartzite for metallurgical purposes. Superior Division produced 310,039 tons of ore assayed at 4.74 percent copper, 0.029 ounce of gold, and 1.03 ounces of silver, compared with 337,618 tons of ore

assayed at 4.74 percent copper, 0.025 ounce of gold, and 0.95 ounce of silver during 1962. The lower production resulted from delays during the change in mining methods in the east replacement area. Metals production at the Magma mine included 14,131 tons of copper, 8,649 ounces of gold, and 287,288 ounces of silver. Development footages at the Magma mine consisted of 16,269 feet of drifts and crosscuts, 6,593 feet of raises, and 9,897 feet of diamond drilling.

According to the annual report of Kennecott Copper Corp., ore production by Ray Mines Division at the Ray mines near Hayden was 7.1 million tons, compared with 7.7 million tons in 1962. Copper production from all sources totaled 62,930 short tons, a 5-percent decline. The average grade of ore mined in 1963 was lower than that mined during the previous year. Increased water in the leaching circuit aided in achieving a 21.3-percent increase in precipitate copper produced during the year. A pilot plant for molybdenite recovery was constructed and experimental work was conducted in preparation for the production of molybdenite.

Pyrite recovered by Ray Mines Division from the milling of base-metal ores at Hayden was roasted in a fluidizing reactor to produce sponge iron and sulfur dioxide gas for manufacturing sulfuric acid, essential to the LPF process used by the company for recovering copper from nonsulfide copper in the ore. The sponge iron produced from the pyrite was used as a precipitant for the dissolved nonsulfide copper.

B. O. W. Mining Co. made shipments of lead concentrate from the Silver Belle-Martinez mine, 15 miles northwest of Florence, to the Asarco El Paso (Tex.) smelter. A new inclined shaft was sunk on the property and a 100-ton-per-day flotation mill constructed. Arizona Silver, Inc., began shipments of lead ore from the Orphan Boy mine in the Mineral Hill mining district 18 miles northeast of Florence.

Arkota Steel Corp. reported shipping from stockpile a small quantity of magnetic concentrate from the Omega mill for use in manufacturing sponge iron.

Nonmetals accounted for 2 percent of the total value of mineral production. Quicklime produced by San Manuel Division was used at the San Manuel concentrator. Perlite produced by Arizona Perlite Roofs, Inc., from the Adams and Iberri mines was expanded in plants at Tucson and in Texas for use in building plaster and as loose-fill insulation, concrete aggregate, and soil-conditioning material. Harborlite Corp. operated the Harborlite mine and shipped the crude perlite to company-owned or controlled expanding plants outside the State. Diatomite was mined by Arizona Gypsum Corp. at the White Cliffs mine near Mammoth for use as a filler. Gypsum produced by Arizona Gypsum Corp., National Gypsum Co., and Garcia Gypsum Co., Inc., from mines near Winkelman and Coolidge was sold or used as a portland cement retarder, for agricultural use, and in manufacturing wallboard and lath.

Santa Cruz.—Because active mining at the Flux mine ceased in mid-October the value of mineral production in Santa Cruz County was reduced 62 percent. Operated by Nash & McFarland, the property had been the largest producer of lead and zinc in the Harshaw district

in recent years. Other metal producers in the county included Alvaro Alvarez & A. Majalca (Indiana Mine), R. C. Bruce (Pittsburgh), Ted Granillo (Estelle-Louise), Platoro Corp. (Austerlitz), E. W. McFarland (Hardshell), White Star Mining Co. (Red Star), and Felix Vargas (Sweetwater).

Yavapai.—The county was the leading producer of lead and zinc in Arizona, second in silver, fourth in gold, and sixth in copper. The combined value of the output of these metals was $22.4 million, 73 percent of the total value of mineral production in the county.

The Iron King mine operated by Shattuck Denn Mining Corp. was the leading producer of lead and zinc in the State and fourth in the production of gold. The total production of ore from the mine was 280,807 tons compared with 271,171 tons in 1962. The Iron King mill recovered 43,685 tons of dry concentrates. The lead-zinc flotation concentrates produced from the ore were shipped to smelters of Asarco at Amarillo, Corpus Christi, and El Paso, Tex.

According to the company annual report Bagdad Copper Corp., principal producer of copper in the county, produced 24,975,173 pounds of copper in 1963, compared with 22,422,539 in 1962, at the Bagdad copper mine located 50 miles west of Prescott. The increase in output was principally the result of increased capacity resulting from the sixth ball mill operating a full year (8 months in 1962) and from an increase in the average grade of ore from 0.73 percent copper in 1962 to 0.86 percent in 1963. The company did not benefit fully from the higher grade ore because much of the increase in grade was in a nonrecoverable form. The molybdenum-recovery section was successfully operated during the entire year. Production of leach copper was 10,341,561 pounds compared with 6,074,357 pounds in 1962. Output of leached copper at the end of the year was at a rate of 1.2 million pounds per month; as the leach operation becomes more systematized, monthly production was expected to be approximately 1.2 million pounds per month, and it was expected that leach production would increase 3 to 4 million pounds over that of 1963. Work at the company pilot plant on refining precipitated copper to a pure powder was completed and largely successful.

Cyprus Mines Corp. stated in its annual report that the flotation mill for the Old Dick and Copper Queen copper-zinc mines near Bagdad processed 112,500 short tons of ore to produce 18,200 tons of copper concentrate and 16,000 tons of zinc concentrate. In 1962, 111,000 tons of ore was treated to produce 16,400 tons of copper concentrate and 17,600 of zinc concentrate. Known ore reserves are small; unless additional ore were found by deep exploration now underway, the property would probably be mined out in 1965.

Arizona Gypsum Corp. quarried gypsum from its mine near Camp Verde and processed it for use in agriculture and as a portland-cement retarder. The tonnage and value of the gypsum produced in 1963 were below those of 1962. Phoenix Cement Co. manufactured masonry and portland cements at its plant near Clarkdale from limestone and miscellaneous clays produced by the company at its Redwall quarry and Lakebed mine. United States Lime Products Division, produced crushed limestone from the Nelson quarry for concrete and roadstone and for use in manufacturing hydrated lime and quicklime.

Quicklime was sold for use by the coke, copper, gas, and steel industries. Hydrated lime was used for water purification; in manufacturing insecticides, fungicides, and disinfectants; in preparing food and food byproducts; and in treating sewage and trade wastes. A small quantity of miscellaneous stone was quarried by contractors for the Arizona State Highway Department. Dimension sandstone and miscellaneous dimension stones were produced by M. C. Canyon, Jasper Dean, Dunbar Stone Co., Howard Gray, R. K. Hamilton, and Grady Smith. Contractors for the Arizona State Highway Department and the Federal Forest Service accounted for most of the sand and gravel produced in the county. The remainder was produced by two commercial producers for use in building construction and for fill.

Yuma.—Accounting for 79 percent of the value of mineral output, sand and gravel was the principal mineral commodity produced. Contractors for the Arizona State Highway Department, Federal Bureau of Reclamation, Federal Bureau of Public Roads, and Yuma County Highway Department produced 511,300 tons of sand and gravel valued at $316,000. Six commercial operators produced 301,300 tons of structural sand and gravel valued at $396,000.

Stone production consisted of 7,328 tons of broken granite used as riprap, 9,440 tons of crushed marble used for terrazzo and roofing granules, 1,920 tons of crushed miscellaneous stone used as concrete and roadstone, and 900 tons of dimension sandstone used for building construction.

Small quantities of gold, silver, and copper—valued at $8,455—were recovered from gold, silver, and copper ores from five lode and three placer operations. The Yuma mine operated by Southern California Chemical Co. and the Sue mine operated by Health & Wealth Club, Inc., were the principal producers.

The old Harqua Hala gold mine in the Ellsworth district near Salome, was reactivated by David Obenstine. Mineral Hills Copper Co. began the production of ore from its property in the Santa Maria district, near Parker, early in December. The ore, reported to contain 1.5 percent copper, will be leached and the precipitates shipped to the Hayden smelter.

The Mineral Industry of Arkansas

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Arkansas Geological Commission, Norman F. Williams, Director and State Geologist, Little Rock, Ark., for collecting information on all minerals except fuels.

By Raymond B. Stroud [1]

ARKANSAS mineral production totaled $167.2 million in value, an increase of about 9 percent over that of 1962. The mineral value established a new high and was 5 percent more than the previous record of $159.5 million registered in 1960. Record production of bromine, cement, gypsum, iron ore, natural gas, and sand and gravel was largely responsible for the overall gain in mineral value; significant increases were recorded for bauxite, clays, gem stones, and abrasive stone. Value of liquefied petroleum gases was virtually the same as in 1962. Phosphate rock production was recorded for the first time since 1912. Total stone output established a new high in value, but quantity was 8 percent less than that of 1962.

TABLE 1.—Mineral production in Arkansas [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	258,691	$2,232	236,077	$2,161
Bauxite—long tons, dried equivalent	1,270,124	14,606	1,478,047	16,701
Clays—thousand short tons	654	1,693	769	1,763
Coal—do	256	1,809	221	1,505
Gem stones	(2)	15	(2)	42
Gypsum—thousand short tons	83	261	(3)	(3)
Iron ore (usable)—thousand long tons	43	296	(3)	(3)
Lime—thousand short tons	350	4,542	167	2,237
Natural gas—million cubic feet	66,213	9,866	76,101	11,796
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	29,415	1,673	26,219	1,466
LP gases—do	69,452	2,432	66,377	2,497
Petroleum (crude)—thousand 42-gallon barrels	27,649	73,546	[4] 27,373	[4] 72,812
Sand and gravel—thousand short tons	10,847	10,006	12,099	13,589
Stone—do	20,611	19,866	18,913	22,727
Zinc (recoverable content of ores, etc.)—short tons	211	49	----------	----------
Value of items that cannot be disclosed: Abrasive stone, bromine, cement, phosphate rock (1963), soapstone, and values indicated by footnote [3]	----------	11,063	----------	17,900
Total	----------	153,955	----------	167,196

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Preliminary figure.

[1] Geologist (mineral deposits), Bureau of Mines, Bartlesville, Okla.

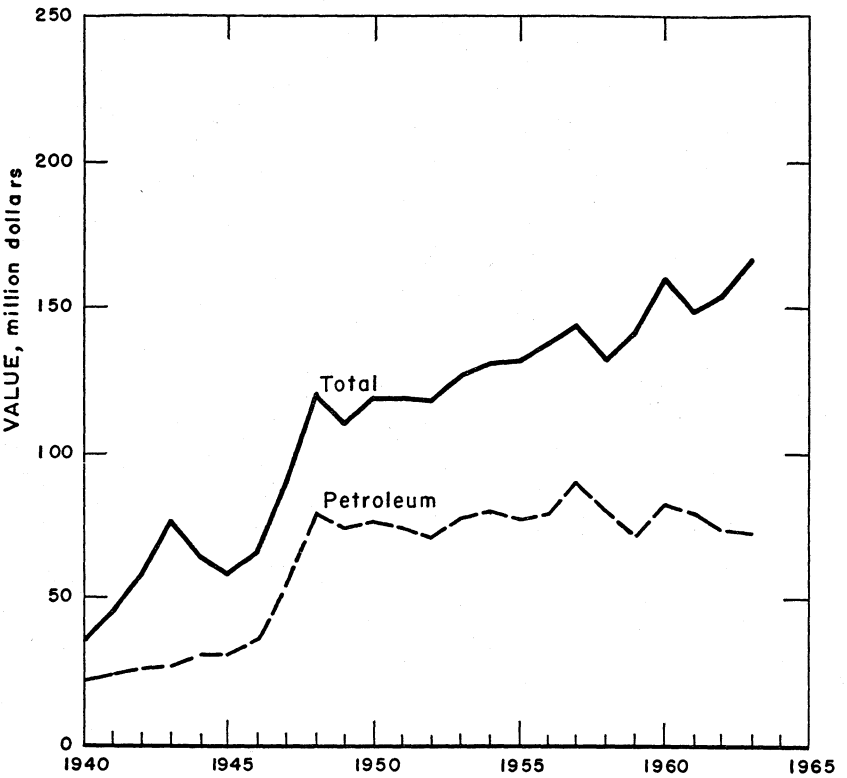


FIGURE 1.—Value of petroleum and total value of mineral production in Arkansas, 1940–63.

Decreases occurred in output of barite, coal, lime, natural gasoline and cycle products, petroleum, and soapstone. No zinc production was reported in 1963.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Principal markets for clay products, cement, sand and gravel, and stone were found in major highway improvement programs, construction of Federal dams and related facilities, and residential and business building. Eighteen Titan missile sites were completed during the year; these had formerly consumed a significant part of construction material output.

At yearend, U.S. Army Corps of Engineers projects were in various stages of completion: Beaver Dam and related facilities, 76 percent complete; Greers Ferry project, 97 percent complete; Dardanelle Lock and Dam and hydroelectric power facilities, 52 percent complete; Arkansas River bank stabilization and channel rectification project, 58

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$140,467	1958	$133,023
1953	142,545	1959	141,596
1954	144,146	1960	158,486
1955	143,588	1961	147,517
1956	142,632	1962	151,475
1957	141,305	1963	162,339

percent complete; Millwood Dam project, 40 percent complete; and access road construction of Gillham Reservoir project and De Gray Dam project, in progress. An estimated 5.3 million tons of crushed limestone, sandstone, and syenite was consumed by the projects in 1963.

Arkansas highway projects, including improvements and new construction, required stone as well as sand and gravel in quantities about 21 percent greater than that used in 1962.

A. P. Green Fire Brick Co. began operating its new, clay-calcining plant near Berger, just southwest of Little Rock. The new plant, much nearer the source of raw material, provides for more efficient operation and expanded capacity.

Dierks Forests, Inc., completed construction of a new wallboard manufacturing plant in Howard County in May. At yearend, plant capacity was 450,000 square feet of ½-inch wallboard per day. The company became the State's second gypsum producer.

Construction of Thomas B. Fitzhugh steam-generating plant, with a capacity of 57,000 kilowatts, was completed in April. Arkansas Electric Co-operative Corp. announced plans to expand plant capacity to 171,000 kilowatts. The expansion program, scheduled to begin in 1965, was slated for completion in 1968. The plant boiler, fired with natural gas, is also equipped to use coal as fuel.

Arkansas Electric Co-operative Corp. announced final plans, late in 1963, for construction of the Carl E. Bailey electric generation station near Augusta, Woodruff County. Rural Electrification Administration approved a loan of $22.5 million to build the plant and transmission lines. Construction of the plant, which will have a capacity of 125,000 kilowatts, was tentatively scheduled to start in the spring of 1964. The boiler will use gas as fuel but also will be equipped to use coal.

Announcement was made that a $25 million experimental nuclear-powered electric plant would be built south of Fayetteville, Washington County. Construction was scheduled to start in 1964. The plant will be a joint project of 16 electric power companies and will have a capacity of 20,000 kilowatts.

Plans for a steel furnace and mill at Stamps were being finalized at yearend. Area Redevelopment Administration funds of more than $977,000 were to help finance the plant. Iron and steel scrap, and possibly iron ore mined near Falcon, would be utilized. The plant would have an electric furnace and a steel-rolling milling to make re-

inforcing bars; plant capacity would be about 6,000 tons of bars per month.

Austral Oil Co., Inc., completed a well producing condensate and natural gas from Lake Erling field, Lafayette County. The well set a new producing depth record in the State with production from 11,034 to 11,060 feet. A flow of 360 barrels of condensate and 3.25 million cubic feet of gas per day was recorded.

Area Redevelopment Administration approved a $56,000 loan to the Lafayette County Industrial Corp. to help finance research aimed at determining feasibility of using iron ore deposits in the county in manufacturing iron oxide pigments.

Employment and Injuries.—Average annual employment in the mining industry diminished for the 6th consecutive year. Decreases occurred in all mineral-producing categories except one; total employment was 4 percent lower than in 1962. Employment in metal mining dropped about 7 percent; in bituminous coal mining, about 11 percent; and in crude petroleum and natural gas production, about 6 percent. Employment in mining and quarrying of nonmetals increased 2 percent. The mining industry payroll was about $24.9 million, less than 1 percent under that of 1962.

Average weekly wages were: Metal mining industry, $110.03, a 5-percent decrease; coal-mining industry, $84.76, a less than 1 percent decrease; crude petroleum and natural gas industry, $100.87, an increase of 4 percent; and nonmetal mining and quarrying industries, $87.20, a 3-percent increase.

Available data indicate that one fatality occurred in nonmetal mining in 1963. There were 146 lost-time accidents—27 in the metals industry and 119 in the nonmetals industry. No fatalities occurred in coal mining, but 12 nonfatal accidents were reported. Injury data applicable to the petroleum and natural gas industry were not available.

TABLE 3.—Average annual employment for selected mineral industries

Industry	1962		1963	
	Employing units	Employment	Employing units	Employment
Metal mining	19	592	16	549
Bituminous coal mining	20	168	20	149
Crude petroleum and natural gas	382	2,703	367	2,537
Nonmetal mining and quarrying	114	1,623	118	1,661
Total	535	5,086	521	4,896

Source: Arkansas Department of Labor, Employment Security Division, Little Rock, Ark.

Water.—Water problems including long-range supply, quality, pollution, reuse, and treatment received increasing attention from Federal and State agencies and private research institutions. The Federal Bureau of Mines conducted a nationwide canvass of the mineral industry to obtain 1962 water use data. The following tables are based on results of the survey.

TABLE 4.—Water use in the mineral industry in 1962

(Million gallons)

	New water	Water re-circulated	Total water use	Water discharged	Water consumed
Quarries and mills	119	936	1,055	73	46
Metal mines and mills	1,240	817	2,057	603	637
Nonmetal mines and mills	746	1,025	1,771	484	262
Sand and gravel mines	7,121	968	8,089	6,797	324
Natural gas processing plants	312	11,311	11,623	96	215
Petroleum	870	715	1,585	12	716
Total	10,408	15,772	26,180	8,065	2,200

TABLE 5.—Water usage of wells drilled by rotary tools, by county, in 1962

(Barrels)

County	Number of wells	Total footage	Fresh water used	Total barrels/foot
Bradley	12	43,542	217,700	5.00
Calhoun	9	25,723	103,000	4.00
Chicot	1	4,278	6,400	1.50
Clark	1	1,600	3,200	2.00
Cleburne	1	2,774	4,160	1.50
Columbia	9	47,044	94,000	2.00
Conway	1	5,954	11,900	2.00
Crawford	7	42,010	105,000	2.50
Desha	1	4,860	9,700	2.00
Faulkner	1	9,383	14,000	1.49
Franklin	22	114,615	229,200	2.00
Hempstead	2	5,306	10,600	2.00
Johnson	6	30,498	53,600	1.76
Lafayette	54	222,644	779,550	3.50
Logan	6	49,456	99,000	2.00
Miller	32	135,317	405,950	3.00
Nevada	13	32,139	64,000	1.99
Ouachita	50	118,047	225,000	1.91
Pope	10	51,254	102,400	2.00
Scott	1	11,680	35,000	3.00
Sebastian	16	106,079	265,200	2.50
Sevier	1	110	50	.45
Union	115	370,310	491,117	1.33
Van Buren	2	5,082	7,600	1.50
White	3	13,439	20,150	1.50
Yell	1	7,903	15,800	2.00
Total	377	1,461,047	3,373,277	2.31

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Production of petroleum, natural gas, natural gas liquids, and coal, ranked in order of significance, contributed the major share of the total value of Arkansas mineral output. Production value of a record amount of natural gas offset value losses for petroleum, natural gas liquids, and coal. Combined value of the four fuel mineral categories increased slightly.

Coal (Bituminous).—Coal output declined for the 4th consecutive year. Quantity and value decreased 14 and 17 percent, respectively, as compared with 1962 data. Increased competition from other fuels and other coal-producing States, as well as lower demand were largely responsible for the drop. Only 11 mines (6 underground and 5 strip) with annual output greater than 1,000 tons were operated as compared with 16 mines (9 underground and 7 strip) in 1962.

Sixty-six percent of the coal production was from strip mines and the remainder was from underground mines. Production from underground mines decreased 16 percent and that from strip mines decreased 12 percent. Four counties listed in order of quantity and value of coal production—Johnson, Franklin, Sebastian, and Logan—were responsible for coal production in the State. Pope County dropped from the list of coal-producing counties.

TABLE 6.—Coal production [1]

(Thousand short tons and thousand dollars)

Year	Short tons	Value	Year	Short tons	Value
1954-58 (average)	503	$3,846	1961	395	$2,888
1959	441	3,482	1962	256	1,809
1960	409	3,116	1963	221	1,505

[1] Data from mines producing 1,000 tons or greater.

Oil and Gas Exploration and Development.—Drilling activity in 25 counties accounted for 208 oil wells and 43 gas wells. There were 175 wells classified as dry holes. Total number of wells drilled increased 25 percent over that of 1962. Ten or more wells were drilled in nine counties. Decreases in drilling occurred in four of the counties having significant activity, and increases in drilling occurred in Crawford, Johnson, Miller, Nevada, and Union Counties. Petroleum and natural gas companies spent several crew-weeks exploring for oil and gas in the State, utilizing seismographic and gravity-meter techniques. Available data indicate that geophysical exploration decreased significantly as compared with 1962.

Fifty-nine percent of the wells resulted in oil and gas production, compared with 45 percent in 1962. Operators in gas-producing counties in north Arkansas completed 40 gas wells as opposed to 26 dry holes. In south Arkansas, 208 oil and 3 gas wells were completed and 149 dry holes were drilled in counties having oil output. Wildcat wells were successful in establishing four oilfields. Field development wells discovered 11 pools and at least 10 fields were extended by successful output wells.

A well drilled in 1957 in Columbia County held the State depth record at 12,925 feet; this well was dry and abandoned. A new depth record for a producing well was established in Lafayette County in 1963 with successful completion of a gas-condensate producer in the Smackover formation at 11,043 to 11,060 feet.

South Arkansas oil and gas production came from Cretaceous and Jurassic formations which contain structural and stratigraphic features conducive to oil and gas accumulation. Four oilfields were discovered in south Arkansas counties, and five pools were established as sources of supply by field development wells. Five secondary recovery projects were begun during the year. Production of oil, gas, and condensate was realized from 144 of the 166 fields discovered as of yearend.

Production of dry natural gas in northern Arkansas was from structural and stratigraphic traps in relatively shallow sands of Pennsylvanian and Mississippian ages and from deeper pay zones of

TABLE 7.—Oil and gas well drilling in 1963, by counties

County	Drilling						Total
	Proved field wells			Exploratory wells			
	Oil	Gas	Dry	Oil	Gas	Dry	
Ashley						4	4
Bradley	2			1		2	5
Calhoun	2					5	7
Columbia	3		1			4	8
Conway						2	2
Crawford		9				1	10
Crittenden						1	1
Franklin		11	5			1	17
Jefferson						1	1
Johnson		10				1	11
Lafayette	6		8	1		10	25
Lee						1	1
Logan		2	1				3
Miller	35		9			4	48
Monroe						1	1
Nevada	23		11			11	45
Ouachita	27		2	1		1	31
Phillips						1	1
Pope		1	5				6
Pulaski						1	1
Randolph						2	2
Sebastian		7	4				11
Sevier						1	1
Union	106	3	53	1		20	183
Woodruff						1	1
Total: 1963	204	43	99	4		76	426
1962	116	31	86	1	5	101	340

Source: Arkansas Oil and Gas Statistical Bulletin, v. 23, No. 12, December 1962 through v. 24, No. 3, March 1964.

Devonian age. Field development wells discovered six new sources of natural gas and outpost drilling successfully extended several gasfields.

Pipeline Construction.—Arkansas-Louisiana Gas Co. completed construction of a $15 million natural gas pipeline from Centrahoma, Okla., to Paris, Ark. The project was the first stage of a $41 million pipeline construction program to reach from Centrahoma to Helena via Jonesboro. The completed pipeline consisted of 83 miles of 24-inch line, 20 miles of 20-inch line, 30 miles of 14-inch line, 2 miles of 10-inch line, and 23 miles of 8-inch line. The Arkoma pipeline provided an outlet for an estimated 3 trillion cubic feet of natural gas and was the first outlet for the largest unconnected proved gas reserve in the midcontinent area. Initial maximum capacity of the pipeline was an estimated 140 million cubic feet per day. The company also constructed two compressor stations on the new pipeline.

Arkansas-Louisiana Gas Co. applied to the Federal Power Commission for permission to construct a 20-inch, 103-mile natural gas pipeline from Driggs, Logan County, northward to Jane, Mo.; estimated cost of the pipeline was $7.3 million. The application also asked permission to construct gathering lines, pipeline laterals, and other facilities to bring additional gas into the new Arkoma pipeline. The company announced plans to construct two compressor stations and enlarge a compressor station near Driggs.

TABLE 8.—Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

	Proved reserves Dec. 31, 1962	Changes in proved reserves, due to extensions and new discoveries in 1963	Proved reserves, Dec. 31, 1963 (production was deducted)	Change from 1962, percent
Crude oil—thousand barrels	246,795	4,764	225,291	−9
Natural gas liquids [1]—do	19,744	1,572	18,695	−5
Natural gas—million cubic feet	1,643,669	220,592	1,792,644	+9

[1] Includes condensate, natural gasoline, and LP gases.

Source: American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. Proved Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas. V. 18, Dec. 31. 1963, pp. 11–12, 21.

Natural Gas.—Total production of natural gas from gasfields in northern and southern Arkansas established a record high. Value of production, nearly $2 million more than that of 1962, marked the 7th consecutive year of increased values. Gasfields in nine north Arkansas counties accounted for 74 percent of the production value. Six southern Arkansas counties produced gas worth $3 million, a gain of about 16 percent; production in Lafayette County accounted for the increase. Leading producers of natural gas, in order of output, were Franklin, Lafayette, Columbia, Sebastian, Pope, and Johnson Counties; value of production exceeded $500,000 in each. Output in Franklin County was 58 percent of total production in north Arkansas. Lafayette County replaced Columbia County as leading gas producer in south Arkansas.

Natural Gas Liquids.—Output of natural gasoline, cycle products, and liquefied petroleum gases declined for the 3d consecutive year. Production of LP gases declined 4 percent in quantity but increased slightly in value. A decline of 11 percent in quantity and 12 percent in value occurred in production of natural gasoline and cycle products. Five natural gasoline plants and one cycling plant produced in three counties throughout the year; Columbia County plants led with more than 60 percent of the output.

TABLE 9.—Gross withdrawals and disposition of natural gas

(Million cubic feet)

Year	Gross withdrawals [1]			Disposition			
	From gas wells	From oil wells	Total	Marketed production [2]		Repressuring	Vented and wasted [3]
				Quantity	Value (thousands)		
1954–58 (average)	22,400	34,800	57,200	31,995	$2,074	19,142	6,063
1959	32,000	40,800	72,800	40,674	3,539	27,488	4,638
1960	45,700	41,100	86,800	55,451	6,599	27,640	3,709
1961	45,800	42,100	87,900	59,547	8,039	25,748	2,605
1962	62,000	41,600	103,600	66,213	9,866	35,315	2,072
1963	57,700	41,500	99,200	76,101	11,796	19,191	3,908

[1] Marketed production plus quantities used in repressuring, vented, and wasted.
[2] Comprises gas sold or consumed by producers, including losses in transmission, quantities added to storage, and increases in gas in pipelines.
[3] Includes direct waste on producing properties and residue blown to air.

TABLE 10.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	43,371	$2,780	55,858	$2,365	99,229	$5,145
1959	40,730	2,523	55,731	3,048	96,461	5,571
1960	34,558	2,148	73,252	3,735	107,810	5,883
1961	27,889	1,640	75,157	3,286	103,046	4,926
1962	29,415	1,673	69,452	2,432	98,867	4,105
1963	26,219	1,466	66,377	2,497	92,596	3,963

Petroleum.—Arkansas petroleum output contributed 44 percent of the State's total mineral value. Quantity and value of output decreased for the 3d consecutive year but was only 1 percent under 1962 figures. There were 6,010 producible oil wells at yearend. Magnolia field, in Columbia County, led in production with about 6.4 million barrels. Ten counties, with Columbia, Union, Lafayette, Ouachita, and Miller as leaders, accounted for most of the petroleum production. Production of comparatively small quantities of oil was recorded for the first time in Johnson and Conway Counties in northern Arkansas. These counties are well-known gas producers in the Arkansas portion of Arkoma Basin.

Five pressure maintenance and secondary recovery projects were started in 1963, and an extension in recovery area was made in one field. At yearend, 29 fields in south Arkansas had secondary recovery or pressure maintenance programs in operation.

TABLE 11.—Crude petroleum production, by fields

(Thousand barrels and thousand dollars)

Field [1]	1962		1963 [2]	
	Quantity	Value	Quantity	Value
Champagnolle			713	$1,897
Dorcheat-Macedonia	518	$1,378		
El Dorado	471	1,253	431	1,146
Fouke	1,067	2,838	1,022	2,718
Lick Creek			368	979
Magnolia	6,334	16,848	6,370	16,944
McKamie	1,836	4,884	569	1,514
Midway	2,106	5,602	2,400	6,384
Sandy Bend			608	1,617
Schuler	1,661	4,418	1,645	4,376
Smackover	3,161	8,408	3,102	8,251
Stephens	1,064	2,830	963	2,562
Village	498	1,325	472	1,255
Wesson	1,381	3,673	1,163	3,094
Other fields [3] [4]	7,552	20,089	7,547	20,075
Total	27,649	73,546	27,373	72,812

[1] Breakdown of individual fields as reported in the Oil and Gas Journal.
[2] Preliminary figures.
[3] Includes oil consumed on leases and net change in stocks held on leases for the State.
[4] Bureau of Mines figures.

TABLE 12.—Crude petroleum production, indicated demand, and stocks in 1963, by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks originating in Arkansas	Month	Production	Indicated demand	Stocks originating in Arkansas
January	2,242	2,092	1,366	August	2,390	2,569	1,248
February	2,121	2,188	1,299	September	2,295	2,381	1,162
March	2,325	2,392	1,232	October	2,353	2,356	1,159
April	2,229	2,117	1,344	November	2,246	2,262	1,143
May	2,331	2,469	1,206	December	2,263	2,295	1,111
June	2,237	2,266	1,177				
July	2,341	2,091	1,427	Total	27,373	27,478	

NONMETALS

Production value of 12 nonmetals accounted for 36 percent of the total value of Arkansas' mineral output. Minerals produced, in order of value, were stone, sand and gravel, cement, bromine, lime, barite, clays, gypsum, soapstone, gem stones, abrasive stone, and phosphate rock. Seven of the mineral commodities contributed substantially to the record total value. Production value of three commodities—lime, barite, and soapstone—decreased. Phosphate rock was produced for the first time since 1912.

Abrasive Stone.—Production of crude novaculite for ultimate use in the manufacture of oilstones and whetstones reversed a 3-year downward trend and increased 15 percent in quantity and 12 percent in value. Three companies reported sales of unfinished stone, quarried in Garland County.

Barite.—Barite production decreased for the 2d consecutive year and was 9 percent less than in 1962; value of output was down 3 percent. Demand for barite used in oil and gas well drilling continued to slacken and was largely responsible for the production loss. The State continued to rank second in the Nation in production of domestic barite. Minark Minerals Co. (formerly U.S. Barite Division, Diversified Industries), Howard County, resumed mining and production of ground barite for well-drilling applications early in 1963.

TABLE 13.—Primary barite sold or used by producers

Year	Short tons	Value (thousands)	Year	Short tons	Value (thousands)
1954-58 (average)	395,993	$3,541	1961	277,855	$2,630
1959	338,539	3,097	1962	258,691	2,232
1960	277,851	2,578	1963	236,077	2,161

Bromine.—Arkansas' two bromine producers—Michigan Chemical Corp. and Arkansas Chemicals, Inc.—established a new bromine production record in the State. The bromine, recovered from brines, was used principally in manufacturing ethylene dibromide, a gasoline additive. Other uses included various compounds for medicinal, photographic, and industrial applications.

Cement.—Impact of the high rate of construction activities in Arkansas was most prevalent in the cement industry. Output of portland and masonry cement by Ideal Cement Co. and Arkansas Cement Co. reached an alltime high in quantity and value. The production upsurge was coincident with high output of stone and sand and gravel. Shipments of cement to Arkansas destinations were at a record high, up 16 percent over 1962.

Clays.—Overall value of Arkansas clay output was 4 percent more than in 1962. Twenty clay producers in 14 counties reported a total tonnage about 18 percent higher than comparable 1962 data. Quantity and value of fire clay production decreased 32 percent and 10 percent, respectively, but was offset by a 56-percent increase in value and output of miscellaneous clay. Clays were used in manufacturing refractory brick, face brick, sewer pipe, building brick, and heavy clay products. Significant quantities of clays were used in lightweight aggregate and cement. Pulaski County led in value of clay production, followed by Hot Spring, Sebastian, Howard and Johnson Counties.

TABLE 14.—Shipments of portland cement to Arkansas consumers

Year	Arkansas (thousand barrels)	Change, percent	
		In Arkansas	In United States
1954–58 (average)	2,016		
1959	2,624	+23	+9
1960	2,590	—1	—7
1961	2,968	+15	+3
1962	3,053	+3	+3
1963	3,556	+16	+5

TABLE 15.—Clays sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Miscellaneous clay [1]		Fire clay		Total clay	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	280	$356	374	$1,590	654	$1,946
1959	383	383	399	2,023	782	2,406
1960	388	387	427	2,069	815	2,456
1961	434	428	339	1,330	773	1,758
1962	368	365	286	1,328	654	1,693
1963	574	573	195	1,190	769	1,763

[1] Includes clay used for cement.

Gem Stones.—Value of gem stones and mineral specimens was the highest on record. Diamonds found in Pike County contributed the largest share of the total value of gem stone production. Quartz crystals and miscellaneous mineral specimens produced in Montgomery and Garland Counties accounted for about 9 percent of the total value.

Gypsum.—Production and value of the commodity increased substantially in 1963. Most of the gain was ascribed to Dierks Forests, Inc., production of gypsum for use in the company-owned wallboard plant. The Dierks wallboard operation, in Howard County, utilized

gypsum mined by open-pit methods. The company drilling program outlined a minable reserve sufficient for many years. Output of Dulin Bauxite Co., formerly the only gypsum producer in the State, gained significantly; its production was used exclusively as an additive in cement.

Lime.—A substantial drop of 48 percent in primary lime production was attributed to an overall decrease in demand for lime used for several chemical and industrial applications. Six companies reported production of primary lime and regenerated lime. Major markets included paper, aluminum, chemical, and petroleum industries. Lesser quantities of lime supplied sugar refining, water purification, agricultural, and building demands. Saline County led the five lime-producing counties in the State.

Phosphate Rock.—Peyton Creek Mining Co. began development of phosphate rock deposits near Leslie, Van Buren County. Company operations were limited at yearend, awaiting results of a core-drilling program. The drilling program, designed to further evaluate resources of phosphate rock in the area, was being carried out under the direction of Arkansas Geological Survey and was partially financed by funds from the Area Redevelopment Administration.

Sand and Gravel.—Output of sand and gravel increased for the 3d consecutive year and outstripped the record year of 1959 by over 400,000 tons. Value of 1963 production ($13.6 million) was 36 percent greater than 1962 value. Production of sand and gravel for both commercial and government-and-contractor major use categories was substantially higher. Average unit value of $1.18 per ton for commercial sand and gravel remained unchanged from 1962; however, average unit value for government-and-contractor sand and gravel increased from 50 cents per ton in 1962 to $1.02 per ton in 1963.

Soapstone.—Output and value of soapstone declined 17 percent. The rock, mined in northern Saline County, was ground by The Milwhite Co., Inc., at Bryant for use in insecticides, roofing, and in rubber compounds.

Stone.—Value of stone output in Arkansas reached a record high and was 14 percent greater than in 1962. Quantity of the stone output, comprised of limestone, marble, sandstone, slate, and syenite, was 8 percent under the 1962 output. Crushed limestone was consumed in road construction, concrete aggregate, cement and lime manufacture, riprap, agricultural limestone, flux, glass and paper manufac-

TABLE 16.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	5,961	$5,674	2,651	$1,716	8,612	$7,390
1959	6,973	7,535	4,723	4,322	11,696	11,857
1960	5,935	6,732	2,257	3,530	8,192	10,262
1961	5,933	6,892	3,456	2,182	9,389	9,074
1962	6,717	7,946	4,130	2,060	10,847	10,006
1963	7,699	9,096	4,400	4,493	12,099	13,589

ture, asphalt and fertilizer fillers, and railroad ballast. Uses of crushed sandstone, in order of importance, were concrete aggregate, roadstone, riprap, and railroad ballast. Syenite was used for riprap, concrete and roadstone, railroad ballast, and roofing granules manufacture. Slate output was used in manufacturing roofing granules and as filler in asphalt and rubber compounds. Sandstone and marble, sawed and dressed, were used in residential and public buildings. Production of stone for commercial uses accounted for 57 percent of total tonnage and 64 percent of total value, virtually the same as in 1962. The stone was mined in 39 counties. Average unit value of commercial stone was $1.35 per ton and value of Government-and-contractor stone was $1.01 per ton, compared with values of $1.05 and 84 cents per ton, respectively, for 1962.

Sulfur (Recovered Elemental).—Byproduct sulfur was extracted at gas cycle plants in Columbia, Lafayette, and Union Counties. Most of the sulfur was recovered by Olin Mathieson Chemical Corp. in Lafayette County. Tonnage and value of sulfur shipments were 4 percent lower than comparable data for 1962.

TABLE 17.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	1,346	$1,434	1,639	$1,745
Paving	946	891	1,071	1,048
Fill	247	135	(1)	(1)
Other [2]	325	1,002	525	1,107
Total sand	2,864	3,462	3,235	3,900
Gravel:				
Building	1,496	2,215	1,747	2,645
Paving	2,220	2,188	2,678	2,528
Fill	86	42	26	12
Other [3]	51	39	13	11
Total gravel	3,853	4,484	4,464	5,196
Total sand and gravel	6,717	7,946	7,699	9,096
Government-and-contractor operations:				
Sand:				
Building	2	3	6	8
Paving	1,837	896	1,385	900
Fill			269	121
Total sand	1,839	899	1,660	1,029
Gravel:				
Paving	2,051	1,058	2,712	3,453
Fill	240	103	28	11
Total gravel	2,291	1,161	2,740	3,464
Total sand and gravel	4,130	2,060	4,400	4,493
Grand total	10,847	10,006	12,099	13,589

[1] Figure withheld to avoid disclosing individual company confidential data, included with "Other".
[2] Includes fill (1963), glass, molding, and other construction, industrial, and ground sand.
[3] Includes railroad ballast and miscellaneous gravel.

TABLE 18.—Sand and gravel production in 1963, by counties

County	Short tons	Value	County	Short tons	Value
Ashley	304,697	$333,266	Madison	23,109	$23,109
Benton	70,568	28,227	Marion	28,275	26,270
Bradley	34,701	35,560	Mississippi	180,683	187,083
Carroll	313,472	187,393	Montgomery	35,567	31,889
Chicot	130,312	130,312	Nevada	4,711	4,093
Clark	60,640	57,940	Ouachita	260,740	274,371
Clay	113,530	74,291	Pike	22,073	39,002
Cleburne	6,325	6,325	Polk	7,962	3,184
Cleveland	13,446	13,446	Pope	372,978	464,789
Columbia	3,598	3,598	St. Francis	331,447	343,347
Crittenden	1,161	1,161	Saline	73,888	131,913
Dallas	25,561	25,561	Scott	13,484	13,484
Desha	126,452	126,452	Searcy	26,328	26,328
Drew	80,802	47,739	Sharp	19,162	19,162
Faulkner	1,229	1,229	Stone	975	390
Grant	103,556	103,556	Union	7,496	7,496
Greene	170,480	164,245	Woodruff	8,681	8,681
Jefferson	119,397	119,397	Yell	2,146	1,006
Lawrence	49,295	46,780	Other counties [1]	8,840,643	10,389,275
Lincoln	101,768	80,240	Total	12,099,000	13,589,252
Logan	7,662	7,662			

[1] Includes Boone, Calhoun, Conway, Craighead, Crawford, Cross, Garland, Hempstead, Hot Spring, Howard, Independence, Izard, Jackson, Lafayette, Miller, Phillips, Poinsett, Pulaski, and Sevier, combined to avoid disclosing individual company confidential data. Undistributed amounts from various counties are also included.

TABLE 19.—Stone sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1959	8,824	$10,424	1962	20,611	$19,866
1960	10,939	13,555	1963	18,913	22,727
1961	12,029	12,402			

METALS

Aluminum.—Primary aluminum production in the United States increased 9 percent over 1962 output. The two aluminum plants of Arkansas continued to add a significant amount to the production total. Increased demand resulted in expanded output at both plants. The plants, which had operated at about 50 percent capacity during most of 1962 and the first part of 1963, increased output to about 75 percent of overall annual capacity in the last two-thirds of the year.

Bauxite.—Production of bauxite increased 16 percent in quantity and 14 percent in value over comparable 1962 data. Demand for aluminum metal accounted for a significant part of the gain, but continued improvement in markets for alumina and calcined bauxite used in manufacturing chemicals also contributed to the rise. Arkansas bauxite output accounted for 97 percent of all U.S. production.

Reynolds Mining Corp. with open-pit and underground mines in Saline and Pulaski Counties was the leading bauxite producer. Aluminum Company of America, with strip mines in Saline County, ranked second.

Iron Ore.—Southwest Enterprises, Inc., continued mining operations in southwestern Nevada County. The crude iron ore was beneficiated in a washing plant and concentrates were sold for use in steel manu-

TABLE 20.—Bauxite mine production and shipments from mines and processing plants to consumers

(Thousand long tons and thousand dollars)

Year	Mine production			Shipments		
	Crude	Dry equivalent	Value	As shipped	Dry equivalent	Value
1954–58 (average)	1,891	1,591	$13,818	1,865	1,596	$15,115
1959	1,940	1,631	17,048	1,827	1,580	17,960
1960	2,327	1,932	20,469	1,876	1,603	18,982
1961	1,419	1,179	13,462	1,244	1,080	13,220
1962	1,523	1,270	14,606	1,714	1,480	17,536
1963	1,771	1,478	16,701	1,724	1,483	17,543

facture and as an additive in cement manufacture. Production was substantially higher than in 1962. A market for some of the iron ore may develop in adjacent Lafayette County when a proposed steel mill is constructed.

Zinc.—Rush Creek Mining & Exploration Co. suspended zinc mining and milling activities in Marion County for an indefinite period. The company reported no shipments of zinc concentrates during the year. Athletic Mining & Smelting Co., Fort Smith, operated its zinc smelter at about 40-percent capacity until mid-November when operations were suspended. A shortage of zinc concentrates necessary to maintain operations reportedly caused the shutdown.

REVIEW BY COUNTIES

Mineral production was recorded in 70 of the 75 counties as compared with 65 in 1962. Value of mineral output increased in 45 counties and decreased in 20; mineral production was reported in 5 counties not having production in 1962. Twenty-one counties reported mineral output value of more than $1 million. Petroleum was produced in 10 counties; natural gas in 15; natural gas liquids in 3; coal in 4; sand and gravel in 58; stone in 39; clays in 14; lime in 5; gem stones and recovered sulfur in 3; barite, bauxite, cement, and gypsum in 2; and abrasive stone, bromine, iron ore, phosphate rock, and soapstone each in 1. Columbia, Saline, Union, Lafayette, and Little River Counties contributed a major part of total mineral production value. Counties with significant production are discussed in the following review.

Ashley.—Value of mineral production, comprised of sand and gravel and lime, was about 34 percent more than in 1962. Lime used in paper fabrication was produced by Crossett Paper Mills at Crossett, but in lesser quantities than in 1962. St. Francis Material Co. and Georgia-Pacific Corp. accounted for most of the sand and gravel used for building and road construction.

Benton.—Total output of crushed dolomitic limestone and sand and gravel was up significantly. Independent Gravel Co. and Ozark Construction, Inc., mined and processed high-magnesium limestone for agricultural fertilizer, road construction, and other uses. Gillioz Co., Inc., and Southeast Construction Co. quarried and crushed lime-

TABLE 21.—Value of mineral production in Arkansas, by counties [1]

County	1962 [2]	1963	Minerals produced in 1963 in order of value
Ashley	$262,225	$352,493	Sand and gravel, lime.
Baxter	11,226	9,268	Stone.
Benton	(3)	373,250	Stone, sand and gravel.
Boone	77,775	351,853	Do.
Bradley	450,059	891,822	Petroleum, sand and gravel.
Calhoun	1,078,064	686,139	Do.
Carroll	2,338,831	1,610,693	Stone, sand and gravel.
Chicot	(3)	130,312	Sand and gravel.
Clark	57,161	91,212	Sand and gravel, stone, clays.
Clay	72,545	74,291	Sand and gravel.
Cleburne	517,679	11,891	Sand and gravel, stone, natural gas.
Cleveland	12,415	13,446	Sand and gravel.
Columbia	31,536,805	35,820,259	Petroleum, natural gas liquids, natural gas, sand and gravel.
Conway	898,706	749,675	Stone, natural gas, sand and gravel, petroleum.
Craighead	98,688	(3)	Sand and gravel, clays.
Crawford	1,933,213	2,043,247	Stone, sand and gravel, natural gas.
Crittenden		1,161	Sand and gravel.
Cross	(3)	(3)	Do.
Dallas		25,561	Do.
Desha	(3)	126,452	Do.
Drew	39,092	47,739	Do.
Faulkner	468,589	325,360	Stone, sand and gravel.
Franklin	4,761,602	5,832,140	Natural gas, coal, stone.
Fulton		55,844	Stone.
Garland	179,855	191,077	Sand and gravel, abrasive stone, stone, gem stones.
Grant		103,556	Sand and gravel.
Greene	120,879	164,245	Do.
Hempstead	39,004	69,513	Sand and gravel, clays.
Hot Spring	3,564,435	3,029,825	Barite, clays, sand and gravel, stone.
Howard	(3)	5,876,748	Cement, stone, gypsum, clays, barite, sand and gravel.
Independence	(3)	1,934,217	Stone, lime, sand and gravel.
Izard	(3)	1,954,482	Stone, sand and gravel.
Jackson	(3)	(3)	Sand and gravel.
Jefferson	(3)	476,929	Lime, sand and gravel, stone.
Johnson	1,406,706	1,824,642	Coal, natural gas, stone, clays, petroleum.
Lafayette	16,403,316	16,141,784	Petroleum, natural gas liquids, natural gas, sand and gravel.
Lawrence	991,075	1,209,315	Stone, sand and gravel.
Lincoln	112,053	80,240	Sand and gravel.
Little River	(3)	(3)	Cement, stone, clays.
Logan	904,126	1,143,184	Stone, natural gas, coal, sand and gravel.
Lonoke	75,732	160,996	Stone, clays.
Madison	(3)	55,935	Stone, sand and gravel.
Marion	86,436	44,725	Sand and gravel, stone.
Miller	5,322,602	6,063,122	Petroleum, sand and gravel, natural gas, clays.
Mississippi	45,000	187,083	Sand and gravel.
Montgomery	(3)	661,599	Slate, sand and gravel, stone, gem stones.
Nevada	1,737,614	1,868,278	Petroleum, iron ore, sand and gravel, natural gas.
Ouachita	9,719,924	7,228,476	Petroleum, sand and gravel, natural gas, clays.
Perry	248,169	377,367	Stone.
Phillips	(3)	(3)	Sand and gravel.
Pike	274,333	403,187	Gypsum, sand and gravel, gem stones.
Poinsett	(3)	(3)	Sand and gravel.
Polk	19,104	38,849	Clays, sand and gravel, stone.
Pope	1,380,603	1,686,120	Natural gas, stone, sand and gravel.
Pulaski	7,347,367	8,378,581	Stone, clays, sand and gravel, bauxite.
Randolph	67,645	80,439	Stone.
St. Francis	196,031	343,347	Sand and gravel.
Saline	17,903,667	18,037,633	Bauxite, lime, sand and gravel, soapstone, slate.
Scott		13,484	Sand and gravel.
Searcy	100,499	34,078	Sand and gravel, stone.
Sebastian	1,943,611	1,649,544	Natural gas, stone, coal, clays.
Sevier	(3)	(3)	Sand and gravel, stone.
Sharp	38,000	84,121	Stone, sand and gravel.
Stone	24,267	390	Sand and gravel.
Union	18,412,149	17,198,688	Petroleum, bromine, natural gas, natural gas liquids, clays, sand and gravel.
Van Buren	12,147	(3)	Stone, phosphate rock.
Washington	328,553	763,391	Stone, natural gas.
White	(3)	581,301	Stone.
Woodruff	7,612	8,681	Sand and gravel.
Yell	(3)	301,687	Stone, sand and gravel.
Undistributed	20,327,811	17,121,033	
Total	153,955,000	167,196,000	

[1] The following counties are not listed because no production was reported in 1962 or 1963: Arkansas, Lee, Monroe, Newton, and Prairie.
[2] Revised figures.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

stone for highway construction. Paul Davis produced sand and gravel for building, paving, and fill.

Boone.—Value of stone and sand and gravel production was about five times that of 1962. The sand and gravel output was used in road construction. McClinton, Inc., mined and crushed Boone limestone for concrete aggregate, agricultural fertilizer, and road construction.

Bradley.—Mineral production value in the county was nearly double that of 1962; a major decrease in sand and gravel output was offset by increased production of petroleum. O'Neill Brothers and Moro Gravel Co. were major sand and gravel producers. Three successful oil wells, including the discovery well of Charivari field, and two dry holes were drilled. The new oil source of supply is in the Nacatoch formation of Cretaceous age.

Calhoun.—The value of mineral output was down 36 percent as compared with that of 1962. St. Francis Material Co., W. W. Grant, and Ouachita Aggregate Co. were the principal producers of sand and gravel. Two field wells were successful as oil producers, but five exploratory wells were dry holes.

Carroll.—Production of stone and sand and gravel continued at a high rate but value of the minerals was considerably lower than in 1962. The county ranked second in value of stone production (limestone) in the State; construction of Beaver Dam by U.S. Army Corps of Engineers accounted for the stone requirements. Garrett Gravel Co. produced sand and gravel for building and construction purposes.

Cleburne.—Near completion of Greers Ferry Dam near Heber Springs accounted for the substantial drop in stone and sand and gravel output which formerly contributed heavily to mineral values.

Columbia.—Production of petroleum, natural gas, natural gas liquids, and sand and gravel had a combined value sufficient to rank the county first in the State for the 7th consecutive year. The county ranked first in petroleum and natural gas liquids output and third in natural gas output. Arkla Chemical Corp. operated its gas-processing plant at Magnolia throughout the year; LP gases, natural gasoline and cycle products, and sulfur were recovered. Three oil wells were completed in proven fields and one field well and four wildcat wells were abandoned as dry holes.

Conway.—Petroleum production in the county was reported for the first time. Total value of mineral output was 17 percent lower than that of 1962. Sandstone output was used principally by the U.S. Army Corps of Engineers in the Dardanelle Lock and Dam construction project.

Craighead.—Wheeler Brick Co., Inc., mined and processed clay for brick manufacture. St. Francis Material Co. and Davenport Sand & Gravel Co. produced sand and gravel for building and paving purposes.

Crawford.—Stone, sand and gravel, and natural gas production was valued at over $2 million in 1963. Although stone output was down, increases in natural gas and sand and gravel output more than counteracted the value deficit. Arkhola Sand & Gravel Co. was the major sand and gravel and sandstone producer. Sandstone was crushed for concrete aggregate, riprap on river stabilization projects, and road

building material. Nine gas wells were drilled in proven fields, and the only wildcat well was dry.

Faulkner.—Construction projects by U.S. Army Corps of Engineers accounted for major sandstone production in the county. W. R. Aldridge & Co. quarried and crushed all of the stone used. Various operations were responsible for minor sand and gravel production.

Franklin.—The county ranked first in natural gas output with a value of more than $5 million. Production of coal and stone contributed substantially to an increase of 22 percent in total value of the county's mineral products. Garland Coal & Mining Co. mined enough coal to rank the county second largest coal producer in Arkansas. D. F. Jones, G. P. Freshour, Mississippi Valley Engineering & Construction Co., and Farrell Construction Co. quarried and crushed sandstone for roadstone, riprap, and concrete aggregate. Six dry holes, including 1 exploratory hole, were drilled; 11 new gas sources of supply were developed by well drilling activities which included 5 dual completions.

Garland.—Diverse production of crude abrasive stone, mineral specimens, stone, and sand and gravel comprised the mineral output. Novaculite, roughly dressed and graded, was shipped outside the State for manufacture of whetstones and oilstones. This mineral commodity is unique among the mineral products of Arkansas. Norton Pike Co., Arkansas Oilstone Co., and Jackson Whetstone Co. increased shipments of crude novaculite. Smith Bros. Construction & Material Co. mined and processed sand and gravel for building purposes. Malvern Minerals Co. mined and crushed silica sand for various purposes including use as a grinding agent for small cast metal parts. Charles Coleman and Garmon Rocks and Minerals gathered and sold quartz crystals.

Hot Spring.—Barite production, the county's leading mineral commodity, decreased in quantity and value; however, the combined output of ground barite by Baroid Division of National Lead Co. and Magnet Cove Barium Corp. was sufficient to rank Arkansas second in the Nation in domestic production of barite. The county ranked second in the State in clay production. Malvern Brick & Tile Co. and Acme Brick Co. (Perla Plant) mined and processed fire clay for manufacturing refractory brick, building brick, and heavy-duty clay products. Acme Brick Co. (Malvern plant) mined and used miscellaneous clay for building brick and tile. Malvern Gravel Co. and Belvedere Sand & Gravel Co. mined, washed and sized sand and gravel from sand and gravel deposits in the flood plains of Ouachita River for concrete aggregate, road construction, and other building purposes. Malvern Gravel Co. mined and crushed novaculite for manufacture of refractory products, railroad ballast, concrete aggregate, and road construction.

Howard.—Ideal Cement Co. mined chalk, marl, and clay for cement manufacture. The company also utilized sand and fine-sized iron ore from other Arkansas counties in cement making. The Minark Co. mined and ground barite for use in manufacture of well-drilling muds. The company also accounted for some sand and gravel output. Dierks Forests, Inc., utilized gypsum mined in the county in manufacturing wallboard at its new Briar plant north of Nashville, Ark.

Independence.—Value of mineral output increased significantly over that of 1962. The county ranked fourth in value of stone production. Batesville White Lime Co. was a leading producer of quicklime and hydrated lime; the company also produced limestone for glass and paper industries, filler in asphalt compounds, mineral food, and concrete aggregate. Southeast Construction Co. and Freshour Corp. quarried substantial quantities of limestone for road construction. Batesville Marble Co. and Wolford Marble Co., Inc., supplied rough-dressed marble for interior and exterior building stone. Galloway Sand & Gravel Co. accounted for the sand and gravel output. Bristow Stone Co. quarried dimension sandstone for building purposes.

Izard.—Izard County ranked second in value of sand and gravel production and fifth in stone output. Silica Products Co., at Guion, and National Silica Co. mined and processed high-quality sand from the St. Peter sandstone formation. Aluminum Company of America and Arkansas Limestone Co. accounted for production of high-grade limestone used in lime manufacture, metallurgical flux, and soil conditioner.

Jefferson.—Value of mineral production gained significantly over that of 1962. Lime, the leading mineral commodity, was produced by Dierks Paper Co. and International Paper Co. at a rate below that of 1962. Pine Bluff Sand & Gravel Co. accounted for most of the sand and gravel output; the materials were used for building and construction projects. Mississippi Valley Engineering & Construction Co. provided crushed sandstone for river stabilization programs.

Johnson.—Total value of the county's mineral output gained about 30 percent as compared with that of 1962. The county led in coal production and ranked sixth in production of natural gas. Coal, the leading commodity in the county, was produced at both underground and strip mines. Prairie Coal Co., Inc., and Kemp-Johnson Coal Co., Inc., led among five operators having outputs of 1,000 tons or more annually. Ten successful gas wells were drilled in proven gasfields; one exploratory well was termed a dry hole. A few hundred barrels of petroleum was produced and was the first output on record in the county. Production of crushed sandstone was reported by five operators. The stone was used for riprap, road construction, fill, and concrete aggregate. Miscellaneous clay was mined and processed for manufacturing brick and heavy clay products by Eureka Brick & Tile Co.

Lafayette.—The county retained fourth place in total value of mineral production, ranked second in output of natural gas and natural gas liquids, and ranked third in petroleum production. Austral Oil Co., Inc., McKamie Gas Cleaning Co., and Sunray DX Oil Co. operated plants throughout the year for recovery of LP gases, natural gasoline and cycle products, and sulfur. Wildcat drilling was successful in discovery of Palm oilfield. The new oil source of supply is in Smackover limestone. Six successful oil wells drilled in known fields established additional sources of oil. Gifford-Hill & Co., Inc., was responsible for most of the county's sand and gravel output.

Lawrence.—The county ranked third in value of stone production. Total value of stone and sand and gravel production increased 22 percent over that of 1962. Ben M. Hogan & Co., Valley Stone Co., Inc., and D. F. Jones Construction Co. produced most of the stone for con-

crete aggregate, roadstone, riprap, and soil conditioner. Black Rock Sand & Gravel Co., Inc., and L. F. Parker accounted for increased production of sand and gravel.

Little River.—Combined value of cement, clays, and stone production was nearly double that of 1962. Arkansas Cement Corp. mined and utilized clays, chalk, and marl for cement manufacture. Ark-La Limestone Corp. produced aglime at a quarry near Foreman.

Logan.—Production of sandstone accounted for over 50 percent of the value of minerals produced in the county. The county led in dimension sandstone output, the value of which was one-third of total stone value. Natural gas was the second most important mineral commodity. Coal and sand and gravel output added to overall mineral value. Four operators—Logan County Building Stone Co., John Schwartz Quarry, Rainbow Stone Co., and Claude C. Hudson—accounted for all dimension sandstone. Ben M. Hogan & Co., Mississippi Valley Engineering & Construction Co., and Souter Construction Co. quarried sandstone for U.S. Army Corps of Engineers and Arkansas Highway Department for riprap, concrete aggregate, and roadstone. Hixon Coal Co. accounted for all reported coal production. J. W. Cotton Gravel Co. produced sand and gravel for building purposes.

Miller.—Value of the mineral output ranked the county eighth in the State. The county was first in value of sand and gravel production, ninth in natural gas output, and fifth in petroleum production. Seventy-seven percent of total mineral value was attributable to petroleum production. The county was second in oil well drilling activity and 35 of 48 wells were successful producers. W. S. Dickey Clay Manufacturing Co. mined fire clay and miscellaneous clay for heavy clay products at its plant near Texarkana. Sand and gravel was produced by Gifford-Hill & Co., Inc., Lambert & Barr, Inc., and McMillan-Burkett Construction Co.

Montgomery.—Value of the county's mineral production increased as a result of stone and sand and gravel production. Bird & Son, Inc., quarried and processed slate for asphalt filler, roofing granules, and slate flour. Four Brothers, Inc., quarried sandstone for road construction. Sand and gravel output was about 10 percent more than in 1962. Quartz crystals were gathered and sold by Coy Drain and Ocus Stanley.

Nevada.—Production of iron ore and petroleum accounted for most of the mineral value in the county. Sand and gravel and natural gas production also contributed to the total value, which increased about 8 percent over that of 1962. Southwest Enterprises, Inc., produced brown iron ore for steel making and cement manufacture.

Ouachita.—Combined production value of petroleum, natural gas, clays, and sand and gravel was enough to rank the county seventh in the State, although the value was nearly $2.5 million less than that of 1962. All of the loss was attributed to decreased petroleum and natural gas values. Hope Brick Works' production of miscellaneous clay for brick and tile was double that of 1962. Value of sand and gravel output was virtually unchanged. Pine Bluff Sand & Gravel Co. and Standard Gravel Co. produced material for building and paving

purposes. The county ranked fourth in petroleum production, by far the most important product. Twenty-eight successful oil wells were drilled, including one wildcat that resulted in discovery of Poison Springs oilfield.

Pike.—Dulin Bauxite Co. quarried and crushed gypsum at a rate significantly higher than in 1962. Value of the gypsum output combined with that of sand and gravel and diamond was 47 percent more than comparable 1962 data. McAlester Fuel Co. mined, washed, and sized sand and gravel from Little Missouri River, near Murfreesboro.

Pope.—Value of combined mineral output increased 22 percent because of large increases in production of stone and sand and gravel. The county ranked fifth in value of sand and gravel. McGeorge Contracting Co. and Mobley Construction Co., Inc., furnished sand and gravel for building and construction purposes. Coal production ceased in the county for the first time in several years. Ben M. Hogan & Co., Mississippi Valley Engineering & Construction Co., and various other contractors supplied crushed sandstone for river development projects. Natural gas was the county's most valuable mineral commodity.

Pulaski.—The county ranked sixth in total value of mineral output. Increased production of stone, sand and gravel, and clays was sufficient to offset a significant drop in bauxite production; total mineral value was more than $1 million higher than that of 1962. The county ranked first in the State in value of stone and clay output and third in sand and gravel production. Big Rock Stone & Material Co., John D. Ott, and Jeffrey Sand Co. produced sand for building, road construction, paving, and other purposes. Markham & Brown Co., Mid-Continent Stone & Construction Co., Mississippi Valley Engineering & Construction Co., and West Lake Quarry & Material Co. supplied crushed and broken syenite to the U.S. Army Corps of Engineers for Arkansas River bank stabilization projects. Big Rock Stone & Material Co. quarried and crushed syenite for riprap, concrete aggregate, roadstone, railroad ballast, and roofing granules. Crushed sandstone for concrete aggregate, riprap, and road construction was produced by Big Rock Stone & Material Co., Jeffrey Stone Co., Pine Bluff Sand & Gravel Co., and West Lake Quarry & Materials Co. U.S. Army Corps of Engineers and Arkansas Highway Department were leading users of the sandstone production.

Stauffer Chemical Co. (Consolidated Chemical Industries Division) and A. P. Green Fire Brick Co. mined and dried kaolinitic clays for use in refractories and manufacture of aluminum sulfate. The latter company began operating its new drying plant near Little Rock.

Bauxite was mined, shipped, or consumed from stock by Campbell Bauxite Co., Porocel Corp., Reynolds Mining Corp., and Stauffer Chemical Co. The companies also operated drying and activating plants for processing bauxite into activated, dried, and chemical materials used by other industries.

Saline.—Bauxite, lime, sand and gravel, soapstone, and slate values, combined, set a new value record and were sufficient to rank the county second among leading mineral-producing counties in the State. Bauxite was the leading mineral commodity and output was up considerably over that of 1962. Value of sand and gravel output was triple that

of 1962. Operating companies and their mineral production were The Milwhite Co., Inc.,—soapstone and slate; American Cyanamid, Aluminum Company of America, and Reynolds Mining Corp.—bauxite; Aluminum Company of Ameria and Reynolds Mining Corp. also produced lime for use in their respective alumina plants in the county; and Holland Gravel Co., Inc., and Stanley Industries—sand and gravel.

Results of an iron exploration project begun in 1962 and ended in 1963 were inconclusive. The work was done by Alpha Minerals Co. and was partially financed by Office of Minerals Exploration.

Searcy.—Total value of the mineral production was about one-third that of 1962. There were significant developments in phosphate rock exploration adjacent to the common boundary of Searcy and Van Buren Counties. Peyton Creek Phosphate Mining Co. recessed its exploratory work to wait results of an Area Redevelopment Administration-sponsored drilling program. The project, supervised by Arkansas Geological Survey, was designed to explore and develop reserves of outcropping beds of phosphate rock. The drilling program began late in the year and had not been concluded at yearend. Preliminary results suggested that the phosphate rock beds were thin and did not persist in areas of large extent.

Sebastian.—Combined value of mineral production was 15 percent lower than that of 1962. Decreased production of construction materials and coal accounted for the value loss; clay and natural gas production increased substantially. The county ranked third in coal output and fourth in natural gas production. W. D. Jeffrey Construction Co., Souter Construction Co., and Carter Construction Co. produced significant quantities of crushed sandstone for U.S. Army Corps of Engineers river stabilization projects. Rescolite Co. mined and expanded clay for lightweight aggregate. Four companies reported 1,000 tons or more of coal mined from two underground and two strip mines. Seven successful gas wells established new sources of supply. Four field wells were abandoned as dry holes.

Union.—The county dropped from second to third place among leading mineral-producing counties in the State. Overall value was 7 percent lower than that of 1962. The county was 2d in petroleum output and 10th in natural gas production. Other mineral production included natural gas liquids, bromine, clays, and sand and gravel. Denton Corp. and Querles Oil Co. operated natural gasoline plants. Petroleum production contributed 77 percent of the mineral value and bromine output increased substantially. The county led in oil well drilling activity; 110 wells resulted in new sources of petroleum and natural gas supply. A wildcat well discovered Ritchie oilfield. The pay zone is in Baker sand of Ozan formation.

Michigan Chemical Corp. and Arkansas Chemicals, Inc., extracted bromine from brines at plants near El Dorado. El Dorado Brick Works mined clay for brick and tile manufacture.

Van Buren.—Total value of the county's mineral output was substantially higher than in 1962. In addition to phosphate rock, crushed sandstone used for road construction comprised the mineral output. Peyton Creek Mining Co. quarried and crushed a limited tonnage of phosphate rock for soil conditioning. The company began develop-

ment of phosphate rock deposits near the border of Searcy and Van Buren Counties early in 1963 but activity was limited throughout the year as the company awaited results of an Area Redevelopment Administration drilling program.

Washington.—Total value of the county's mineral production was more than twice that of 1962. A significant increase in stone output was largely responsible for the gain. McClinton Bros. Co. quarried and crushed limestone for concrete aggregate, roadstone, and soil conditioner. Natural gas production increased slightly in quantity and value.

White.—Crushed sandstone was the only mineral product in the county. Acme Materials Co., Inc., and G. P. Freshour quarried sandstone for concrete aggregate and highway construction projects.

Yell.—Value of the mineral production was more than twice that of 1962. Four companies—Ben M. Hogan & Co., Little Rock Quarry Co., Inc., Carter Construction Co., and Mississippi Valley Engineering & Construction Co.—produced crushed sandstone for riprap, concrete aggregate, and roadstone for U.S. Army Corps of Engineers and Arkansas Highway Department.

The Mineral Industry of California

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the California Department of Natural Resources, Division of Mines and Geology, for the collection of mineral data.

By L. E. Davis [1]

CALIFORNIA's 1963 mineral production was valued at $1,525 million, an increase of $58 million over that of 1962 and the highest production since 1957. The mineral fuels group accounted for 66 percent of the total, nonmetallic minerals for 31 percent, and metals for 3 percent. The combined value of mineral fuels (petroleum, natural gas, and natural gas liquids) rose above $1 billion for the first time in 5 years. A large part of the total value gain was credited to a higher natural gas yield although an increase also was reported for petroleum. The second largest value increase was that of usable iron ore shipments, due entirely to a higher production rate at the Eagle Mountain facilities of Kaiser Steel Corp. Important production advances were made in the nonmetallic minerals group, most notable of which were in cement, stone, and sand and gravel. Tin concentrate was produced and shipped from the Meeke-Hogan mine, Kern County, where the State's last tin production was reported in 1944.

[1] Physical scientist, Bureau of Mines, San Francisco, Calif.

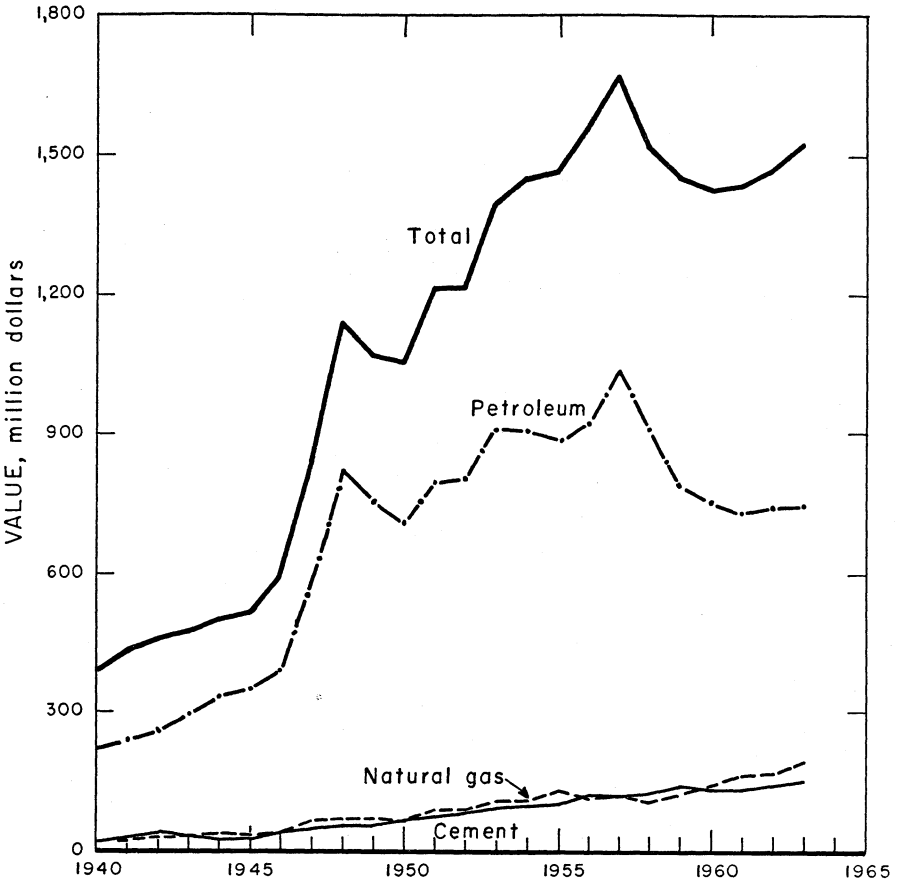


FIGURE 1.—Value of petroleum, natural gas, cement, and total value of mineral production in California, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production.The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 1.—Mineral production in California [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Asbestos short tons	(2)	(2)	19,591	$1,547
Barite (crude) do	6,945	$133	5,082	76
Boron minerals do	646,613	49,336	700,183	54,981
Cement [3] 376-pound barrels	43,667,000	139,151	46,278,000	147,656
Clays short tons	3,137,000	7,349	3,395,000	8,631
Copper (recoverable content of ores, etc.) do	1,162	716	916	564
Feldspar long tons	(2)	(2)	75,516	(2)
Gem stones	(4)	200	(4)	200
Gold (recoverable content of ores, etc.) troy ounces	106,272	3,720	86,867	3,040
Gypsum short tons	1,747,000	4,113	1,756,000	4,222
Lead (recoverable contents of ores, etc.) do	455	84	823	178
Lime do	470,000	8,454	487,000	8,932
Magnesium compounds from sea water and bitterns (partly estimated) M_gO equivalent do	76,445	6,077	82,397	6,135
Mercury 76-pound flasks	15,951	3,050	13,592	2,575
Mica, scrap short tons	(2)	(2)	977	14
Natural gas million cubic feet	564,220	163,624	646,486	189,420
Natural gas liquids:				
Natural gasoline and cycle products thousand gallons	716,904	54,460	715,303	54,188
LP gases do	407,378	19,294	393,503	17,329
Peat short tons	33,900	331	39,873	450
Petroleum (crude) thousand 42-gallon barrels	296,590	741,475	[5] 300,733	[5] 745,818
Pumice, pumicite and volcanic cinder short tons	573,000	2,615	460,000	2,017
Salt do	1,643,000	(2)	1,716,000	(2)
Sand and gravel do	107,660,000	124,922	112,185,000	128,178
Silver (recoverable content of ores, etc.) troy ounces	133,000	144	157,000	200
Stone [6] short tons	34,776,000	54,722	37,977,000	58,253
Sulfur ore long tons	(2)	(2)	785	4
Talc, pyrophyllite and soapstone short tons	117,912	1,339	120,452	1,427
Wollastonite do	(2)	(2)	3,000	28
Zinc (recoverable content of ores, etc.) do	322	74	101	23
Value of items that cannot be disclosed: Bromine, calcium chloride, carbon dioxide, masonry cement, coal (lignite), diatomite, iodine, iron ore, lithium minerals, manganiferous ores, (1962), molybdenum, perlite, platinum-group metals, potassium salts, pyrites (1962), rare-earth metals, sodium carbonate, sodium sulfate, tin (1963), tungsten concentrate, uranium (1963), and values indicated by footnote 2		81,957		89,873
Total		[7] 1,467,340		1,525,359

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Excludes masonry cement included with "Value of items that cannot be disclosed."
[4] Weight not recorded.
[5] Preliminary figure.
[6] Includes slate.
[7] Revised figure.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$1,472,563	1958	$1,517,452
1953	1,580,145	1959	1,455,773
1954	1,580,246	1960	1,417,472
1955	1,543,805	1961	1,417,656
1956	1,596,391	1962	1,433,150
1957	1,659,008	1963	1,487,892

Employment and Injuries.—Employment in the mineral industries (excluding officeworkers and the mineral fuels industries) was 3 percent below that of 1962, according to preliminary data compiled by the Federal Bureau of Mines. Only the stone quarry group registered an employment increase. Total lost-time injuries and fatalities declined, with no fatalities reported for the nonmetallic mine and mill group. Metal mines and mills fatalities dropped from two to one; stone as well as sand and gravel operations each reported one more fatality than in 1962. Injury frequency rates declined in all categories, with an overall decline from 19 to 15.73.

Thirty-seven California participants in the Bureau of Mines 1963 National Safety Competition reported no lost-time injuries during the year. They included 1 underground limestone quarry, 2 diatomite open-pit mines, 1 open-pit gypsum mine, 3 lime plants, 9 stone quarries (7 limestone, 1 dolomite, 1 miscellaneous stone), and 21 sand and gravel operations. The Eliot No. 104 plant of Pacific Cement & Aggregates, Inc. won the highest honors in the pit group of the National Sand and Gravel Safety Competition for the 2d consecutive year. Employees at the plant worked 147,507 man-hours in 1963 without a disabling work injury.

A health and safety study of metal and nonmetal mines was completed by the Bureau of Mines and a report submitted to Congress in response to Public Law 87-300. Copies of the report are available for review at all Bureau of Mines Health and Safety District and Subdistrict offices.

TABLE 3.—Employment and injuries in the mineral industries [1]

Industry	1962 [2]					
	Employees	Man-hours (thousands)	Injuries			Injury frequency rate [4]
			Fatal	Nonfatal	Total	
Metal mines and mills [5]	2,161	3,765	2	93	95	25.23
Nonmetallic mines and mills	4,663	9,524	2	189	191	20.05
Stone quarries	4,796	11,074	5	144	149	13.45
Sand and gravel operations	5,917	11,164	8	232	240	21.50
Total	17,537	35,527	17	658	675	19.00

Industry	1963 [3]					
	Employees	Man-hours (thousands)	Injuries			Injury frequency rate [4]
			Fatal	Nonfatal	Total	
Metal mines and mills [5]	2,096	3,536	1	56	57	16.12
Nonmetallic mines and mills	4,454	9,554		159	159	16.64
Stone quarries	4,986	11,281	6	144	150	13.30
Sand and gravel operations	5,490	10,216	9	169	178	17.42
Total	17,026	34,587	16	528	544	15.73

[1] Excludes the mineral fuels industry and officeworkers.
[2] Final figures.
[3] Preliminary figures.
[4] Total number of disabling injuries during the year per million man-hours.
[5] Includes metallurgical plants to avoid disclosing individual company confidential data.

Consumption, Trade, and Markets.—California was the leading State in diversity of mineral production and in the value of raw materials consumed. Production exceeded consumption only in those instances where California was the sole or principal domestic source. Out-of-State sources were essential for many mineral requirements, particularly mineral fuels. Refinery receipts of crude oil (all sources) rose 21 percent from 1962, but natural gas receipts were only 1 percent higher. Plants within the State processed 2 percent more wet gas, yet the output of natural gas liquids was only 1 percent lower. Although two States produced more petroleum, California consumed more petroleum products than any other State; five States had a greater natural gas yield yet only Texas consumed more.

Nearly 10 million motor vehicles were registered in California in 1963, and the number of operating retail service stations had increased to 21,207 at yearend. Again, the State derived about 16 percent of its total tax revenue from fuels used in motor vehicles and motor transportation.

In 1963, 48 different mineral commodities were produced in California. The State was the sole domestic source for boron minerals and compounds, the leader in sand and gravel production by a wide margin, and the principal producer of diatomite, gypsum, mercury, rare-earth concentrates, sodium sulfate, sulfur ore, and tungsten concentrate. California plants also processed many nonmetal ores from other States, principally Arizona and Nevada.

In many instances metal ores and concentrates were processed outside the State. Exceptions were the primary lead smelter and zinc fuming plant of American Smelting & Refining Co., Contra Costa County; the integrated steel plant of Kaiser Steel Corp., San Bernardino County; and the tungsten mill and chemical plant of Union Carbide Nuclear Co., Inyo County.

TABLE 4.—Principal custom mills, commercial grinding plants, and primary smelters in 1963

Company	County	Nearest city or town	Minerals processed	Remarks
C. K. Williams (Anchor Minerals Division).	Alameda	Emeryville	Nonmetals	Commercial grinding.
American Smelting & Refining Co.	Contra Costa	Selby	Lead, zinc, silver, gold.	Smelter, refinery, and fuming plant.
The Wilbur Ellis Co.[1]	Fresno	Fresno	Nonmetals	Custom mill.
Huntley Industrial Minerals Co.	Inyo	Bishop	do	Do.
Union Carbide Nuclear Co.	do	do	Tungsten ore and concentrates.	1,000-ton-per-day flotation chemical plant.
Butte Lode Mining Co.	Kern	Randsburg	Gold and silver.	Stamp mill, amalgamation and gravity concentrator.
American Minerals Co.	Los Angeles	Los Angeles	Nonmetals	Commercial grinding.
Western Talc Co.	do	do	do	Contract grinding.
Industrial Minerals & Chemical Co.	Sacramento	Florin	do	Do.
New Idria Mining & Chemical Co.	San Benito	Idria	Mercury	Custom mill.
Kaiser Steel Corp.	San Bernardino.	Fontana	Iron ore	Blast furnaces, steel plants, and fabricating plants.
C. K. Williams (Anchor Minerals Division).	do	Victorville	Nonmetals	Commercial grinding.
Wildberg Bros. Smelting & Refining Co.	San Francisco.	San Francisco.	Gold, silver, and platinum.	Smelting, refining, and manufacturing.
Yuba Minerals & Milling Co.	Sutter	Sutter	Nonmetals	Custom mill.

[1] Formerly operated by Fresno Agricultural Chemical Co.

TABLE 5.—Sand and gravel, crushed stone, and portland cement sold or used in 1963, by method of transportation

(Thousand short tons)

Material	Railroad	Motortruck	Waterway	Not stated [1]	Total
Sand and gravel (commercial)	3,935	89,898	(2)	(2)	93,833
Crushed stone (commercial)	3,565	26,349	1,429	(2)	31,343
Portland cement	1,546	7,147	(2)	7	8,700

[1] Includes interplant transfers to batching units, etc.
[2] Included with "Motortruck" to avoid disclosing individual company confidential data.

Trends and Developments.—Development of the Asphalto oil field, Kern County (discovered in December 1962 and one of the largest discoveries in recent years), progressed throughout 1963. At yearend the Asphalto field was producing at the rate of 15,000 barrels daily. The field created much interest in view of its location in an area of old fields approaching full development. Continued development of the Brentwood field, Contra Costa County, was considered significant in that the field was producing 3,000 barrels daily in December in an area previously recognized as a dry natural gas province.

The planning and construction of hydrocracking units was the dominant trend in refining in 1963. Completed units and related hydrogen supply plants were reported by Signal Oil & Gas Co. at Bakersfield and by Tidewater Oil Co. at Avon. Five other similar plants were planned or under construction. Shell Oil Co. began a modification program at its Martinez refinery to increase crude oil capacity by 30,000 barrels a day and gasoline production capacity by 37,000 barrels a day. In May, Shell purchased a 49-tract lease off northern California from the Federal Government, paying $11.4 million for 266,865 acres. The company began drilling on this lease before yearend. Standard Oil Co. of California began operating a new plant at its El Segundo refinery designed to improve the quality of furnace and diesel oils and completed a new unit at its Richmond refinery to manufacture alpha olefin chemicals. Standard also completed plans to expand and modernize its facilities at Richmond to increase gasoline output by 40 percent.

Occidental Petroleum Corp. made its first natural gas deliveries to Pacific Gas & Electric Co. from the Lathrop field early in 1963. At yearend, more than 18 billion cubic feet of gas had been delivered. Richfield Oil Co. placed in operation a 12-inch gas transmission line from the Midway-Sunset field to the North Coles Levee field designed to deliver gas to a steam electric-generating plant near Ventura. Shell, jointly with another producer, began operating a pipeline and moving gas from Contra Costa County fields to Shell's chemical plant at Shell Point. At Avon, Tidewater, in an agreement with Monsanto Chemical Co., placed in operation a new sulfur plant with a capacity of 132 tons a day.

In Federal court, Los Angeles County, approval was given to a $6 million settlement in the Federal Government's damage suit against the State of California, the city of Long Beach, and operators of the Wilmington field. The suit had been filed to recover damages to the Navy's shipyard as a result of surface subsidence caused by withdrawal of oil from the Wilmington field.

Union Carbide Nuclear Co. began operating its asbestos pilot plant at King City, Monterey County. Jefferson Lake Asbestos Co. reduced

its Calaveras County asbestos mine and plant activities to one shift a day in September, citing a depressed market as the reason. Kaiser Aluminum & Chemical Corp. placed its experimental high-purity basic refractories materials facility in operation at Moss Landing, Monterey County. Merck & Co., Inc., completed its $1 million modernization program at the Marine Magnesium plant in South San Francisco. National Gypsum Co. announced the start of construction in September on a $5 million gypsum products plant at Richmond. The Flintkote Co. acquired a 13-acre site at Fremont, Alameda County, for planned construction of a $4 to $5 million gypsum products manufacturing plant. Dow Chemical Co. announced that its Seal Beach, Orange County plant would be deactivated by September 1964 and its iodine production transferred to Midland, Mich. Expansion of the Lucerne Valley plant, San Bernardino County, of Permanente Cement Co. was completed early in 1963. Capacity of the plant was doubled to 5,400,000 barrels annually. Stauffer Chemical Co. announced plans to expand its borax plant at Westend, San Bernardino County.

In March, Pacific Gas and Electric Co. completed installation of its second 12,500-kilowatt geothermal unit at its Geysers powerplant, Sonoma County. Magma Power Co. and associated companies provided steam for the units from 11 wells. Magma developed an area 1.5 miles west of the Geysers plant with six recently drilled wells and PG&E planned feasibility studies for additional power development. During the year, Magma drilled eight wells in Sonoma County. Near Niland, Imperial County, one well each was drilled by Western Geothermal Co., Earth Energy, Inc., and Shell Oil Co. In addition to being a source of geothermal power, the well brines hold promise for production of various chemicals.

American Tin Corp. leased the Meeke-Hogan (Hogan-Mallery) mine near Gorman, Kern County, from Tejon Ranch Co., mined ore, and produced and shipped tin concentrate, the first tin produced in California since 1944. The first shipment of Australian rutile concentrate arrived in September at the E. I. du Pont de Nemours & Co., Inc., new titanium dioxide plant at Antioch, Contra Costa County. American Potash & Chemical Corp. stated that its titanium dioxide plant, originally scheduled for Mojave, Calif., would be built in Mississippi instead. Bethlehem Steel Co. purchased a 1,800-acre site at Pinole Point on San Francisco Bay. The tract is large enough for an integrated steel plant. Bethlehem had shut down all its open-hearth furnaces at South San Francisco in 1962. Kaiser Steel Corp. began constructing a pelletizing plant at Eagle Mountain, Riverside County, to fulfill requirements on a new contract to supply 6 million tons of pelletized iron-ore concentrate to Japanese markets and to provide ore production capacity necessary to the long-term support of the company's Fontana steel plant.

TABLE 6.—Office of Minerals Exploration contracts in force during 1963

County and contractor	Commodity	Contract [1]	
		Date	Total amount
Inyo: William R. Noack	Copper	Sept. 27, 1960 [2]	$60,910
Plumas:			
California Alluvial Mining Corp	Gold-Platinum	Oct. 3, 1963 [3]	46,920
Armin Speckert, Sr	Gold	Jan. 23, 1963	61,078
San Luis Obispo: Selby & Dawson	Mercury	Aug. 22, 1963 [3]	45,389
Sierra:			
Best Mines Co., Inc	Gold	Apr. 12, 1963	[4] 80,090
S. E. & K. M. Brainerd	do	Oct. 18, 1963 [3]	15,080
Consolidated Alleghany	do	Oct. 24, 1963 [3]	101,220
Dickey Exploration	do	Sept. 12, 1963 [3]	65,520
Gold Queen Mining Co	do	Oct. 1, 1962	[5] 39,450
Original Sixteen to One	do	Oct. 31, 1963 [3 6]	46,600

[1] Government participation, 50 percent in all contracts.
[2] Certified Aug. 23, 1963.
[3] Effective date of amendment.
[4] Terminated fourth quarter of 1963.
[5] Terminated third quarter of 1963.
[6] Active but recessed.

Legislation and Government Programs.—Public land orders restored about 275,000 acres of land to mineral location and leasing under U.S. mining laws, more than half of which was restored by agencies of the U.S. Department of the Interior. Other land orders withdrew nearly 160,000 acres for use by Federal agencies, principally by the U.S. Forest Service, the National Park Service, and the Bureau of Outdoor Recreation. During 1963, California received U.S. Treasury checks totaling $2,788,411.04 in bonuses, royalties, and rentals from mineral leasing on Federal lands within the State borders, about $190,000 more than in 1962.

Under the Lead-Zinc Stabilization Program, authorized under Public Law 87–347, three California producers had been certified since its enactment in October 1962. At yearend, two had made application for recertification. No new applications were received, or certifications made, in 1963. Payments were made to the two active participants—Foreman and Foreman, Defense mine and Paul Bare, Santa Rosa mine, both in Inyo County. Total 1963 payments were for 367 tons of lead. No payments were made for zinc although the metal was included in the original application for the Santa Rosa mine.

For the year ending December 31, 1963, the Office of Minerals Exploration (OME) received over 500 requests for application forms by persons interested in exploring for minerals in California. Thirteen applications were processed during the period—seven for gold, three for gold-silver, two for silver, and one for mercury. After an on-site examination by the OME field officer, five applications were denied, three were canceled when the applicants failed to provide necessary information for processing the applications, and four were pending at yearend. Of 10 contracts that were active all or part of the year, 6 were still in force, 2 were completed, 1 was terminated by agreement, and 1 was recessed.

The Bureau of Mines initiated resource studies in California on iron ore, gold, silver, copper, lead, zinc, and pozzolanic materials and continued work on the availability and utilization of mineral fillers. As a part of a cooperative project with the California Division of Mines and Geology, reconnaissance examinations were made of barite and nickeliferous laterite deposits.

Water.—During 1963, the Bureau of Mines conducted a national water survey of the mineral industries for calendar year 1962. The results of the survey in California are shown in tables 7, 8, and 9.

Probably the most notable revelations resulting from the survey are volume of new water used (total water entering system) for each dollar of production value and volume of new water consumer (lost through evaporation, processing, and product content but not including water discharged or recirculated) by mineral groups. Metal mines and mills used six times as much new water per dollar of production value as did the nonmetallic minerals group (including stone as well as sand and gravel), which used about six times as much as the mineral fuels group (including well drilling, secondary recovery, and natural gas processing). In total water use, mineral fuels used more than all other mineral categories combined.

Oil and gas well drilling data for over 10 million feet revealed an average of 1.31 barrels of water used per foot of hole drilled. Nearly all (97 percent) of the water used was fresh—the remainder saline or brackish. Although wide variations from well to well existed in barrels of water per foot of hole, no definite use pattern could be established in the different geographic areas of the State.

Data were obtained on total water injected in 97 out of the 135 secondary recovery projects in California. For projects reported, 475 million barrels of water was injected, 97.5 percent of which was saline. Natural gas processing plants used 3,012 million barrels of water and recirculated all but 54 million. Twelve million of the 54 million barrels recirculated was discharged; 42 million barrels was unrecovered.

TABLE 7.—Water use in the mineral industries,[1] by industry during 1962

(Million gallons)

Industry	New water	Recirculated water	Total water	Discharged water	Consumed water
Metal mines and mills	38,774	7,284	46,058	38,576	198
Nonmetallic mines and mills	3,311	2,255	5,566	2,880	431
Stone quarries	1,768	481	2,249	1,596	172
Sand and gravel operations	22,781	7,141	29,922	20,291	2,490
Petroleum and natural gas processing	11,673	135,368	147,041	535	11,138
Total	78,307	152,529	230,836	63,878	14,429

[1] Excluding coal (lignite).

TABLE 8.—Total water usage of wells drilled in 1962, by counties

County	Number of wells	Total footage drilled	Barrels of water used			Average barrels per foot
			Fresh	Saline	Other	
Alameda	1	4,012	4,012			1.00
Butte	12	65,594	24,270			.37
Colusa	41	315,012	189,007			.60
Contra Costa	30	161,009	162,619			1.01
Fresno	51	886,194	5,307,075			5.99
Glenn	19	106,182	41,411			.39
Humboldt	6	37,131	12,996			.35
Kern	1,436	3,365,872	2,994,904	159,074	77,259	.96
Kings	9	48,774	110,382			2.26
Lassen	1	840	340			.40
Los Angeles	261	1,235,648	1,363,847	6,500		1.11
Madera	9	52,129	80,846			1.55
Mendocino	3	7,862	7,862			1.00
Merced	8	69,383	27,059			.39
Monterey	77	216,758	309,964			1.43
Orange	126	625,218	898,304	14,514		1.46
Plumas	1	1,285	1,800			1.40
Sacramento	24	169,450	91,503			.54
San Benito	1	3,420	5,301			1.55
San Bernardino	31	117,590	11,759			.10
San Diego	4	6,320	4,100			.65
San Joaquin	66	494,899	321,684			.65
San Luis Obispo	24	70,371	65,445			.93
San Mateo	1	1,274	510			.40
Santa Barbara	108	534,810	294,539	127,200		.79
Santa Clara	1	3,555	1,360			.38
Solano	30	175,934	114,357			.65
Sonoma	3	6,213	14,476			2.33
Stanislaus	6	54,931	23,620			.43
Sutter	70	605,279	520,540			.86
Tehama	19	90,183	45,993			.51
Tulare	3	5,966	9,247			1.55
Ventura	86	696,624	69,662			1.00
Yolo	26	174,533	108,210			.62
Total	2,594	10,410,255	13,239,004	307,288	77,259	1.31

TABLE 9.—Water use in the mineral industry,[1] by counties in 1962

(Thousand gallons)

County	New water	Recirculated water	Total water	Discharged water	Consumed water
Alameda	3,266,324	2,402,773	5,669,097	3,018,825	247,499
Alpine	2,090		2,090	1,880	210
Amador	192,718	375,460	568,178	158,668	34,050
Butte	41,674	8,000	49,674	30,373	11,301
Calaveras	72,582		72,582	58,058	14,524
Colusa	6,732		6,732	6,645	87
Contra Costa	223,388	340,500	563,888	207,163	16,225
Del Norte	30,929	8,400	39,329	27,843	3,086
El Dorado	323,941	34,992	358,933	249,271	74,670
Fresno	784,052	7,187,554	7,971,606	603,093	180,959
Glenn	11,000		11,000	11,000	
Humboldt	220,958	55,000	275,958	191,969	28,989
Imperial	1,000		1,000	1,000	
Inyo	627,453		627,453	622,953	4,500
Kern	1,651,907	49,462,378	51,114,285	871,824	780,083
Kings	116,205	11,042,524	11,158,729	15,984	100,221
Lake	13,870	1,000	14,870	12,588	1,282
Lassen	10		10	10	
Los Angeles	4,443,418	22,250,869	26,694,287	3,549,230	894,188
Madera	353,884	52,128	406,012	348,800	5,084
Marin	1,001,073		1,001,073	956,073	45,000
Mariposa	34,924		34,924	33,424	1,500
Mendocino	81,613	16,000	97,613	69,338	12,275
Merced	120,641	9,500	130,141	110,641	10,000
Modoc	2,720		2,720	2,720	
Mono	349		349	349	
Monterey	572,092	343,600	915,692	558,138	13,954
Napa	72,917	9,888	82,805	62,813	10,104
Nevada	4,875,662	40,000	4,915,662	4,875,392	270
Orange	1,626,241	1,188,368	2,814,609	1,294,327	331,914
Placer	160,003		160,003	152,703	7,300
Plumas	28,390	52,680	81,070	28,390	
Riverside	1,046,734	8,249,224	9,295,958	772,724	274,010
Sacramento	951,001	139,500	1,090,501	874,979	76,022
San Benito	134,502	112,000	246,502	124,548	9,954
San Bernardino	2,694,011	1,974,362	4,668,373	2,064,600	629,411
San Diego	1,513,030	1,454,798	2,967,828	1,102,486	410,544
San Joaquin	602,626	238,000	840,626	569,146	33,480
San Luis Obispo	51,474	2,236,316	2,287,790	34,701	16,773
San Mateo	179,327	35,000	214,327	143,837	35,490
Santa Barbara	688,724	7,155,104	7,843,828	456,889	231,835
Santa Clara	151,476	139,160	290,636	126,158	25,318
Santa Cruz	165,603	319,780	485,383	129,597	36,006
Shasta	210,976		210,976	201,096	9,880
Sierra	442,389		442,389	442,305	84
Siskiyou	2,624		2,624	2,624	
Solano	57,196		57,196	54,196	3,000
Sonoma	568,854	5,300	574,154	523,536	45,318
Stanislaus	132,053		132,053	121,119	10,934
Sutter	1,663		1,663		1,663
Trinity	77,184		77,184	77,184	
Tulare	78,421	6,000	84,421	68,846	9,575
Tuolumne	316		316	316	
Ventura	1,060,349	24,457,872	25,518,221	691,967	368,382
Yolo	367,120		367,120	362,020	5,100
Yuba	36,772,161		36,772,161	36,768,502	3,659
Undistributed[2]	9,396,593	11,124,883	20,521,476	33,048	9,363,545
Total[3]	78,307,167	152,528,913	230,836,080	63,877,909	14,429,258

[1] Excluding coal (lignite).
[2] Includes wells and secondary drilling.
[3] Data may not add to totals shown due to rounding.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Carbon Black.—Nearly 82 million pounds of carbon black was produced, a 49-percent increase over that of 1962. The value of the 1963 production was $4.9 million, an increase of 66 percent. All California-produced carbon blacks were furnace blacks and six grades were made—high abrasion furnace (HAF), fast extrusion furnace (FEF), general purpose furnace (GPF), semireinforcing furnace (SRF), in-

747-416—64——12

termediate abrasion furnace (ISAF), and thermal. Continental Carbon Co. produced HAF and FEF at Bakersfield, Kern County; United Carbon Co. produced all grades except thermal at Mojave, Kern County; and Shell Chemical Corp. produced thermal black as a by-product of the manufacture of ammonia fertilizers at Pittsburg, Contra Costa County. The carbon blacks were used by the rubber and metal industries.

Carbon Dioxide.—Carbon dioxide was extracted from natural gas by Tidewater Oil Co. in a natural gasoline plant near Taft, Kern County. Production rose well above the 1962 figure. The product was sold to aircraft companies for freezing rivets and to manufacturers of carbonated beverages. Standard Oil Co. of California also extracted carbon dioxide at a plant in the same area to insure that pipeline specifications would be met; the carbon dioxide recovered was not marketed.

Coal (Lignite).—American Lignite Products Co., Inc., mined lignite at its open-pit mine near Ione, Amador County, and was the only commercial lignite producer in California. Production was virtually the same as in 1962. The company processed the mineral principally for recovery of montan wax. Several grades of wax were produced for the carbon paper, polish, and rubber industries.

Coke.—The only coking facilities in California were those operated by Kaiser Steel Corp. at its integrated Fontana steel plant. Most of the coke was consumed in the producer's blast furnaces. Production was several thousand tons higher than in 1962. The coking coal came from mines in New Mexico and Utah operated by Kaiser. In addition to this captive coal, nearly 300,000 tons was purchased from Colorado and a negligible amount from West Virginia.

Natural Gas.—Marketed production of natural gas rose 15 percent from 1962 with 57 percent of the output coming from oil zones. Development of the Lathrop dry-gas field, San Joaquin County, was the most significant single factor contributing to the overall increase, although increased yields were reported from the following fields: Bunker, Solano County; Grimes, Colusa, and Sutter Counties; Sutter Buttes, Sutter County; and Gaviota and Molino Offshore, Santa Barbara County. Withdrawals from these six fields accounted for nearly 75 percent of the increase in production.

Five new gasfields and seven new gas pools were discovered. Development drilling was most prevalent in the following fields: Sutter Buttes, West Grimes (Colusa County), Lathrop, McMullin Ranch (San Joaquin County), West Thornton (Sacramento and San Joaquin Counties), Molino Offshore, and El Segundo (Los Angeles County). Pipeline receipts were down only 1 percent from 1962 figures. The volume of gas injected for repressuring and pressure maintenance declined 2 percent. Less than 1 percent of the net gas withdrawn was vented or otherwise lost.

Natural Gas Liquids.—Production of natural gas liquids declined 1 percent despite a 2-percent increase in the total volume (549,077 million cubic feet) of natural gas processed. Sixty-five percent of the natural gas liquids was natural gasoline and cycle products, and 35 percent was liquified petroleum (LP) gas.

Two plants were shut down during 1963 and two new plants went on stream, leaving 66 operating plants at yearend. The plants were in eight contiguous counties of the Los Angeles Basin, the southern coastal area, and the San Joaquin Valley. The value of the natural gasoline and cycle products output was about 1 percent less than in

TABLE 10.—Natural gas, natural gas liquids, and petroleum produced in 1963, by counties

County	Natural gas [1] (million cubic feet)		Natural gas liquids		Petroleum [1] (thousand barrels)
	Oil zones	Dry gas zones	Natural gasoline and cycle products (thousand gallons)	LP-gases (thousand gallons)	
Butte		9,369			
Colusa		15,724			
Contra Costa	2,762	2,058			487
Fresno	27,167	119	(2)	(2)	25,254
Glenn		18,074			
Humboldt		2,057			
Kern	109,315	7,976	184,161	139,862	95,257
Kings	16,878	1,658	(2)	(2)	1,232
Los Angeles	82,979	2,742	193,487	66,987	78,254
Madera		1,936			
Monterey	4,608				10,175
Orange	32,299		88,911	17,345	31,762
Riverside					3
Sacramento		52,330			
San Benito	249	825			196
San Bernardino	112	40,106			76
San Joaquin	646				
San Luis Obispo	9		(2)	(2)	1,219
San Mateo	27,617	25,769			76
Santa Barbara			70,244	50,197	26,149
Solano		44,933			1
Sonoma		68			
Sutter		39,924			
Tehama		1,155			
Tulare		5,220			56
Ventura	65,148	142	127,238	73,079	30,647
Yolo		2,059			
Undistributed			51,262	46,033	
Total	[3] 369,789	274,244	715,303	393,503	300,854

[1] Quantity figures for natural gas and petroleum by courtesy of California Department of Natural Resources, Division of Oil & Gas.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes natural gas vented and wasted.

1962, with the unit price virtually unchanged at 7.6 cents a gallon; LP gas production value dropped 10 percent on a unit value of 4.4 cents a gallon.

Peat.—Peat production rose 29 percent to about 44,000 tons, compared with 1962. Five deposits in four counties were active throughout the year. Of the total output, 58 percent was reed-sedge peat from Contra Costa and Riverside Counties, 39 percent was moss peat from Modoc County, and 3 percent was peat humus from Orange County. General soil improvement uses consumed 80 percent of the shipments, and the remainder was used for such purposes as plant packaging, mushroom culture, and an ingredient in mixed fertilizers.

The Modoc County moss peat bog near Likely was operated by American-Modoc, Inc., until May, at which time the operation was taken over by John G. Harris of Likely. The average unit value for peat, all types and grades, increased $1.53, to $11.29 a ton, compared with 1962.

Petroleum.—Oilfields in 16 counties (Contra Costa County added in 1963) yielded 1 percent more petroleum than in 1962. Kern County had the highest production, and Los Angeles County was second highest. Nine counties produced more than 1 million barrels each. Six of the 16 producing counties registered production increases; 10 had declines.

Operators filed 2,884 notices of intention to drill, 2,211 new wells were completed to production, and 590 holes were abandoned. The footage drilled (including service wells) was 10,066,738 feet, a slight increase from that of 1962. Five oilfield discoveries resulted from drilling 460 exploratory wells. The exploratory footage was 2,490,000 feet, about one-fourth the total. Discovery of commercial oil in the Brentwood field, Contra Costa County, was significant in that it extended the northern limit of California oil production about 40 miles into what was formerly considered a dry-gas province.

There were 135 water-injection projects, 41 gas-injection projects, and 15 combination water and gas injection projects in active operation at yearend, compared with 133, 43, and 12, respectively, a year earlier. Sixteen LP gas injection programs were known to have been in operation, an increase of four over those of 1962. Heavy crude oil production was stimulated by several methods; the principal consisted of the use of various downhole heaters to reduce the viscosity of the oil. Results were usually successful but to varying degrees. The use of steam and hot water as injection media created much interest but was largely experimental and the results were not made known. However, a marked increase in the number of projects undertaken in 1963 suggested that the results were encouraging. The number of reported in-situ combustion projects in heavy-crude oilfields was 12, compared with 6 in 1962.

Principal refinery construction, completed or in progress, included hydrocracking units at Hanford (Caminol Co.), Martinez (Shell Oil Co.), Bakersfield (Signal Oil & Gas Co.), Richmond (Standard Oil Co. of California), Avon (Tidewater Oil Co.), Wilmington (Union Oil Co. of California), and Santa Fe Springs (Wilshire Oil Co.). At Martinez, Shell was constructing a catalytic cracking unit also. The State's total operating crude oil throughput capacity at refineries was 1,354,740 barrels daily at yearend, 2 percent above that of 1962. In November, Humble Oil & Refining Co. and Tidewater announced plans whereby Humble would purchase all of Tidewater's West Coast marketing and refining facilities for $329 million. Actual take-over was scheduled for an undisclosed date in 1964.

NONMETALS

Asbestos.—Union Carbide Nuclear Corp. began pilot-scale operations at its new wet-process asbestos fiber mill near King City, Monterey County. The company mine is located a few miles away near Coalinga, San Benito County. There were five producers in 1963—Atlas Mineral Corp., Coalinga Asbestos, Inc., both in Fresno County, Asbestos Bonding Co. in Napa County, Jefferson Lake Asbestos Corp. in Calaveras County, and Union Carbide in San Benito County. Two years earlier Asbestos Bonding was the State's only producer of asbestos fiber.

Philip Carey Co. acquired the Lillis Ranch claims near Cantua Creek that had been abandoned by Asbestos Corp. early in the year. U.S. Asbestos Corp. assumed control of the Todd Industries, Inc., property and plant in November and planned fiber shipments as soon as mill modifications were completed.

Barite.—Crude barite production dropped to less than 20 percent of the 1962 output. Before yearend, two of the State's three producers

had ceased operations. Baroid Division, National Lead Co., leased the Loftus claims, Shasta County, from The Glidden Co., and shipped crude barite to its Merced County plant. A relatively small tonnage was shipped from the Gunther Canyon barite property, Inyo County, to a grinder in Los Angeles County. Organic Mineral Sales, Ltd., mined crude barite at the White Swan deposit, Imperial County, but reported no shipments for 1963. Macco Corp. did not mine barite but did ship crude ore from stockpile at the Barite King mine, Tulare County, to its Rosamond plant, Kern County.

Shipments of ground barite were down 9 percent from 1962, reflecting a decline in demand for its use in drilling muds. Crude barite from Nevada mines accounted for 98 percent of all barite ground in California.

Boron Minerals and Compounds.—Bedded borate deposits in Kern and Inyo Counties and brines at Searles Lake were the sources for all U.S. production and most of the world supply of boron minerals and compounds. American Potash & Chemical Corp. and Stauffer Chemical Co. (formerly West End Chemical Co.) refined boron compounds in plants at Searles Lake. Stauffer Chemical Co. also produced high-purity boron compounds in its San Francisco chemical plant from purchased Kern County crude borates. Kern and Los Angeles County refineries were operated by U.S. Borax & Chemical Corp., using crude borates mined by the company at Boron, Kern County. Kern County Land Co. and U.S. Borax mined colemanite near Ryan and Furnace Creek, respectively, in Inyo County. A partially refined borate produced by U.S. Borax was used in compounding a fire-retardant chemical by the State and Federal Forest Service agencies in controlling forest and brush fires. Crude borates also were used as weed killers to a limited extent on railroad right-of-ways.

Bromine and Bromine Compounds.—Production of elemental bromine by American Potash & Chemical Co. at its Trona plant, San Bernardino County, was slightly above the 1962 figure. The output was consumed principally in making bromine compounds for use by the chemical and pharmaceutical industries. In its Newark, Alameda County plant, Inorganic Chemicals Division, FMC Corp., recovered liquid elemental bromine from salt-works bitterns and converted it to ethylene dibromide. The compound was sold chiefly for use as a soil and seed fumigant, although some was consumed in compounding an antiknock ingredient for gasoline.

Calcium Chloride.—Liquid calcium chloride was recovered from Bristol Lake brines, San Bernardino County, by Leslie Salt Co. (formerly California Salt Co.) and National Chloride Co. of America. A slightly larger total quantity was produced and marketed than in 1962. Hill Bros. Chemical Co. purchased the crude liquid and prepared a high quality flake product in a plant near Bristol Lake. Production and sales of flake calcium chloride also were higher. The products were marketed principally in southern California, Nevada, and Arizona for hygroscopic and fireproofing uses.

Cement.—Heavy construction activity stimulated California's portland cement industry to a 5-percent production increase to 86 percent of the 1962 capacity. Record shipments of more than 46 million barrels were made from the State's 13 cement mills. The volume rose nearly 7 million since 1958 and over 14 million since 1953. Markets within the State received 91 percent of the shipments—about 26 mil-

lion barrels to southern California and 16 million to northern California. Shipments to Nevada were over 2 million barrels.

Sales to suppliers of ready-mixed concrete were about 2 million barrels above those of 1962. Six northern California plants shipped nearly 17 million barrels by truck and the remaining 1 million barrels by rail and boat. Bulk shipments were nearly 16 million barrels and bagged 2 million. The seven southern plants shipped about 21 million barrels by truck and over 7 million by rail with bulk shipments about 24 million barrels and bagged nearly 5 million barrels.

Cement plant capacity increased nearly 3 million barrels annually as a result of expansion completion at Cushenbury and Colton, San Bernardino County. Millions of dollars were spent to improve or rebuild at many other plants in anticipation of future demands. Plans also were announced for expansion of the 2-year-old white-cement plant at Crestmore, Riverside County, one of five such plants in the United States.

Experimental flotation work begun in 1940 by Permanente Cement Co. to beneficiate the low-grade limestone fraction in its limestone deposits of Permanente, Calif., was the basis for commercial operation begun in 1963. The company estimated that 338,327 tons of froth flotation and slimes concentrate were produced in the first 8 months of the year from 448,945 tons of low-grade limestone (70.8 percent $CaCO_3$). The flotation operation reflected a reduced stripping ratio and increased quarry life.[2]

Total apparent consumption of portland cement in California during 1963 was 42,318,000 barrels, of which only 165,000 barrels came from out-of-State plants.

TABLE 11.—Finished portland cement

(Thousand 376-pound barrels and thousand dollars)

District[1]	Active plants	Capacity Dec. 31	Production	Shipments from mills			Stocks at mills Dec. 31	Estimated consumption
				Quantity	Value			
					Total	Average per barrel		
1962:								
Northern California	6	20,900	17,340	17,345	$57,297	$3.30	1,218	14,520
Southern California	7	32,520	26,489	26,322	81,854	3.11	1,683	25,347
Total	13	53,420	43,829	43,667	139,151	3.19	2,901	39,867
1963:								
Northern California	6	20,850	17,973	18,028	58,839	3.26	1,164	15,883
Southern California	7	35,400	28,119	28,250	88,817	3.14	1,553	26,435
Total	13	56,250	46,092	46,278	147,656	3.19	2,717	42,318

[1] Northern and Southern California are divided by the northern boundaries of San Luis Obispo and Kern Counties and the western boundaries of Inyo and Mono Counties.

[2] Kleiber, J. C., and Meisel, G. M. Floating Limestone at Permanente. Min. Eng., v. 16, No. 3, March 1964, pp. 39–49.

TABLE 12.—Source and destination of shipments of portland cement

(Thousand 376-pound barrels)

Destination	Source				Total	
	Northern California mills		Southern California mills			
	1962	1963	1962	1963	1962	1963
Northern California	14,083	15,145	390	620	14,473	15,765
Southern California	653	657	24,625	25,731	25,278	26,388
Nevada	411	500	1,165	1,565	1,576	2,065
Oregon	[1]	[1]	[1]	[1]	[2]	[3]
Arizona			115	288	115	288
Utah			23	29	23	29
Other	[4] 2,198	[5] 1,726	[6] 4	[7] 17	2,202	1,743
Total	17,345	18,028	26,322	28,250	43,667	46,278
Building material dealers	1,578	1,635	3,318	3,495	4,896	5,130
Concrete product manufacturers	1,501	1,471	2,512	3,140	4,013	4,611
Ready-mixed concrete	11,225	11,904	18,283	19,646	29,508	31,550
Contractors and Government agencies	2,992	2,965	2,029	1,862	5,021	4,827
Miscellaneous and own use	49	53	180	107	229	160
Total	17,345	18,028	26,322	28,250	43,667	46,278

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Included with "Other;" total 958,000 barrels shipped from northern and southern California to Oregon.
[3] Included with "Other;" total 922,000 barrels shipped from northern and southern California to Oregon.
[4] Includes Oregon, Washington, Montana, Alaska, Hawaii, and foreign countries.
[5] Includes Oregon, Washington, Idaho, Alaska, and foreign countries.
[6] Includes Oregon, Washington, Idaho, Colorado, Hawaii, and foreign countries.
[7] Includes Oregon, Washington, Idaho, Colorado, New Mexico, Texas, Michigan, Hawaii, and foreign countries.

Clays.—Nearly 3.4 million tons of clay was mined at captive operations, an increase of 8 percent compared with 1962. Open-market sales reached 247,000 tons, an increase of 11 percent. Miscellaneous clays for making heavy clay products and portland cement accounted for 82 percent of the total; fire clay for 16 percent; and all other clays for 2 percent. Kaolin was mined from one Mono County deposit and two properties in Orange County; fullers earth from one mine in Inyo County; and bentonite from three mines in San Bernardino, two in Inyo, and one each in Imperial and San Benito Counties. Clay from one of the three San Bernardino County bentonite deposits was classified as a variety of montmorillonite and was processed by the producer principally for use in making pharmaceuticals and cosmetics. Ball clay output was limited to four mines—two in San Bernardino County and two in Stanislaus County.

TABLE 13.—Clays production, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Contra Costa	58,401	$87,850	58,560	$88,265
Imperial	405	3,067	(1)	(1)
Kern	75,772	129,381	79,935	125,935
Los Angeles	437,124	575,637	437,834	573,210
Madera	7,314	9,143	7,418	9,273
Orange	89,956	417,680	114,729	459,888
Riverside	538,432	1,361,657	497,780	1,391,655
Sacramento	25,300	34,302	24,460	35,591
San Bernardino	144,024	477,971	210,702	756,078
San Joaquin	23,738	37,761	20,826	44,430
San Luis Obispo	9,675	12,094	6,250	7,813
Santa Clara	22,100	22,100	(1)	(1)
Sonoma	32,787	13,115	(1)	(1)
Tulare	2,000	2,500	3,200	4,000
Undistributed [2]	1,669,974	4,164,662	1,933,587	4,534,692
Total	3,137,002	7,348,920	3,395,281	8,030,830

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes, Alameda, Amador, Calaveras, Fresno, Inyo, Lake, Marin, Mono, Napa, Placer, San Benito, San Diego, San Mateo, Santa Cruz, Shasta, Stanislaus, Sutter, Tuolumne, Ventura, and Yuba counties, and counties indicated by footnote 1.

Diatomite.—A high percentage of the diatomite production came from three open-pit operations near Lompoc in Santa Barbara County. Only two other properties were active, a new deposit near Lompoc and a diatomaceous silica pit in Napa County. Sales of crude and prepared diatomite rose 8 percent. The greatest demand was for filter grade material, followed in order by filler, lightweight aggregate, pozzolan cement, insulation, and absorbent uses. In all instances preparation plants were near pit sites.

Feldspar.—Sand from dunes on the Monterey peninsula were mined and processed by Del Monte Properties Co. and Owens-Illinois Glass Co. principally for its feldspar content. Del Monte removed heavy minerals by froth flotation and used the same process to produce a silica concentrate and a silica-feldspar mixture. The products were blended and ground to customer specifications. Owens-Illinois used magnetic separators to remove heavy minerals and shipped the feldspathic sand to company glass plants. Overall outputs were above those for 1962, but the quantities ground for special use categories were lower.

Gem Stones.—More than 90 varieties of gem materials and mineral specimens were collected in 37 counties by commercial and amateur collectors, mineralogical societies and clubs, and gem dealers. San Bernardino County yielded the greatest variety, followed by Riverside, Kern, Los Angeles, Inyo, and Santa Barbara Counties. Principal gem materials collected were obsidian, agate, travertine, onyx, and jade. The Davis Creek and Lassen Creek areas of Modoc County yielded most of the obsidian. Appreciable quantities of agate were found in various areas of Kern, Riverside, and San Bernardino Counties; travertine in Imperial, Inyo, and Santa Barbara Counties; onyx in Colusa, Inyo, Kern, Lake, San Bernardino, and Santa Barbara Counties; and jade in El Dorado, Mendocino, Riverside, Siskiyou, and Tulare Counties. Significant quantities of alabaster, chalcedony, garnet, gold and rose quartz, howlite, jadeite, jasper, marble, mar-

casite, palm wood, petrified wood, rhodonite, and vesuvianite were also collected at various locations throughout the State.

Gypsum.—The demand for gypsum in building products, agriculture, and as cement retarder helped raise mine production of the crude mineral to nearly 2 million tons in 1963, and receipts of gypsum from mines in Nevada and Mexico also were substantially greater than in 1962. Kern County mines yielded 914,000 tons, chiefly for agricultural use. Agricultural gypsum (gypsite) was mined in five other counties and byproduct gypsum was produced in three counties at chemical and fertilizer plants.

Production of calcined gypsum from all crude sources rose to a record 1,017,000 tons, a 21-percent increase over the 1962 output. The crude mineral was calcined at six wallboard plants—two in central California and four in southern California. National Gypsum Co. began constructing its first California calcining and wallboard plant in Contra Costa County. Pending completion of the plant, which is expected by August 1964, the company continued to supply its California customers with gypsum products from facilities in Arizona. National Gypsum also planned completion of a second plant in Los Angeles County late in 1965. Both plants were to be supplied with crude gypsum from Mexico. The Blue Diamond Co., division of The Flintkote Co., acquired an Alameda County site in Fremont and announced plans to build a multimillion dollar gypsum products plant. When completed in 1965, the plant was to supply the company's Oregon and Northern California customers. The Blue Diamond mine in Nevada will supply crude gypsum to the Fremont plant.

Iodine.—Crude iodine was extracted from waste oil well brines of the Los Angeles basin (Los Angeles and Orange Counties) in the Seal Beach plant of Dow Chemical Co. The company consumed some of the iodine in the manufacture of titanium tetraiodide and potassium iodide. In its 1963 annual report, Dow stated it would reevaluate its decision to transfer all of its iodine production to its Michigan plant by late 1964.

At Compton, Los Angeles County, Deepwater Chemical Co. produced potassium and silver iodide, potassium and calcium iodate, and resublimed iodine from purchased crude iodine.

Lime.—Output of lime and dead-burned dolomite increased to 487,000 tons in 1963. Producers sold 141,000 tons on the open market and used 346,000 tons in a variety of products. A higher demand for lime in construction, refractories, and particularly chemical and industrial uses, more than offset a decline in agricultural requirements. Commercial producers operated lime plants in El Dorado, Monterey, San Bernardino, and Tuolumne Counties. Sugar companies used lime kilns in five northern and three southern California counties to supply 161,000 tons of lime to sugar-beet processing plants.

C. K. Williams & Co., division of Chas. Pfizer & Co., Inc. (formerly Anchor Minerals & Chemicals, Inc.), started an expansion of facilities at its pilot lime plant in San Bernardino County. The plant, previously operated by Victorville Lime Rock Co., utilized a fluidized-bed kiln, the first of its type in California. Full-scale operation was expected in 1964. California Portland Cement Co. closed its lime plant at Colton. The plant had been producing lime for the company's cement customers.

Lithium Minerals and Compounds.—Lithium in the brines of Searles Lake, San Bernardino County, was recovered in the form of dilithium

sodium phosphate by American Potash & Chemical Corp. in its Trona plant, and converted to lithium carbonate. The lithium carbonate was sold as a source for lithium oxide in high-purity glass and as a substitute for lead oxide in ceramic glazes. Production and consumption of dilithium sodium phosphate were virtually unchanged from 1962.

Magnesium Compounds.—Production and producer consumption and sales of all magnesia grades were higher than in 1962. Sales of magnesium compounds, except the carbonate and trisilicate, also rose. Plants operated by Inorganic Chemical Division, FMC Corp. in Alameda and San Diego Counties extracted magnesium hydroxide and magnesium chloride, respectively, from purchased salt-works bitterns. Magnesium hydroxide was recovered from seawater by Kaiser Aluminum and Chemical Corp. (Monterey County) and Merck & Co., Inc. (San Mateo County). Most of the output at the Kaiser plant was consumed by the producer in the manufacture of refractories, used to a large extent in the Kaiser steel plant at Fontana, Calif.

Mica.—Crude mica (sericite schist) was mined and ground by Western Non-Metallics near Ogilby, Imperial County, for use in the manufacture of roofing materials and mined at the New Frontier property near Needles, San Bernardino County, for use as an ingredient in stucco. Sunshine Mica Co. dry-ground scrap mica at Los Nietos, Los Angeles County, using crude mica from South Dakota and Idaho as well as crude mica imported from India. Virtually all the plant product was consumed in the manufacture of paint and roofing material.

Perlite.—Production of crude perlite was slightly lower than in 1962 but the tonnage sold and used was virtually unchanged. California had one major producer, American Perlite Co., which mined perlite from its Fish Springs quarry and shipped it to expansion plants in Fresno and Los Angeles Counties. In addition, Perlite Rock Co. expanded crude perlite from the Alvo mine in Napa County for its own use in various construction products and Polaris Perlite Co., Inc., (new) shipped crude perlite from a deposit near Barstow, San Bernardino County, to its expansion plant in Tucson, Ariz.

Fourteen perlite expansion plants were in operation, an increase of three plants compared with 1962. Sales of the expanded product increased 14 percent. About 50 percent of the expanded perlite was consumed in plaster aggregate, 17 percent in filter aids, 12 percent in wallboard, 8 percent in insulation, 4 percent each in paint products and soil conditioners, and 5 percent in all other uses.

Potassium Salts.—American Potash & Chemical Corp. was the only producer of potassium compounds. The company extracted potassium chloride (muriate of potash) at Trona, San Bernardino County, from Searles Lake brines. Some of the output was converted to potassium sulfate. Muriate production was below the 1962 figure but sales were higher and yearend stocks were substantially reduced.

The California Bureau of Chemistry reported that 2,789 tons of potassium chloride and 7,964 tons of potassium sulfate were sold for direct application to soils in the State. Additional quantities were consumed in the manufacture of commercial fertilizers. A relatively large tonnage of muriate was exported to Japan; lesser quantities were consigned to Canadian customers. Potassium sulfate was shipped to Canada and Mexico.

Pumice.—The combined output of pumice, pumicite, and volcanic cinder was 20 percent below that in 1962. The chief reason for the decline was reduced demand for volcanic cinder in the maintenance of State highways in Shasta and Modoc Counties and as railroad ballast by Southern Pacific Co. and McCloud River Railroad in Siskiyou County. The combined tonnage of pumice and pumicite shipped to customers was 13 percent higher than in 1962, but totaled only one-fourth the tonnage of volcanic cinder. About 83 percent of all shipments were used in road construction, as concrete aggregate, or railroad ballast; 12 percent was purchased for decorative use (landscaping) and as abrasive or in cleansing compounds; and the remaining 5 percent was sold for soil conditioning, roofing granules, filler in insecticides, and insulation. Nearly 73 percent of the combined output was sold or used as prepared material (crushed, screened, and/or ground before shipment).

TABLE 14.—Pumice[1] sold or used by producers in 1963, by counties

County	Crude		Prepared		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Imperial			2,268	$10,600	2,268	$10,600
Kern			1,000	42,000	1,000	42,000
Shasta	11,358	$23,814	88,821	177,704	100,179	201,518
Siskiyou	83,648	167,342	54,517	103,326	138,165	270,668
Tehama	(2)	(2)	2,325	4,400	2,325	4,400
Tuolumne			27,800	55,600	27,800	55,600
Other counties[3]	29,344	366,596	158,789	1,065,244	188,133	1,431,840
Total	124,350	557,752	335,520	1,458,874	459,870	2,016,626

[1] Includes pumicite and volcanic cinder.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Other counties."
[3] Includes Inyo, Lake, Lassen, Madera, Modoc, Mono, San Bernardino, and Tehama counties, and counties indicated by footnote 2.

Pyrite.—Stocks of pyrite concentrate held by Mountain Copper Co. on December 31, 1962, were shipped (intercompany) in 1963. The company had closed its mine at Iron Mountain, Shasta County, late in 1962.

Salt.—Six producers operated 11 plants in eight counties to recover salt by solar evaporation. Much of the output came from the San Francisco Bay area. An additional tonnage was produced by vacuum-pan evaporation in an Alameda County plant, and some rock salt was mined in San Bernardino County. Shipments were made to all Western States (including Alaska and Hawaii) and to Canada, Far East and Central American countries, and the South Pacific Islands.

Although the salt was marketed for a wide variety of uses, the major consumers were the chemical, food processing, and water softening industries.

Sand and Gravel.—Sand and gravel production exceeded 100 million tons for the third successive year, reaching a record high of over 112 million tons. Structural sand and gravel output increased 3 percent, and the output for paving rose 2 percent above the 1962 figures. Commercial producers who reported gains supplied the materials for base course and concrete aggregate in private and public construction projects. Most of the commercial plants reporting gains were in Alameda, Los Angeles, and San Bernardino Counties. Production from Los

Angeles County was nearly one-fourth the State total. Production exceeded 5 million tons in six counties—Alameda, Los Angeles, Orange, Sacramento, San Bernardino, and San Diego.

The average unit price for sand and gravel was $1.14 a ton, 2 cents less than in 1962. A 5-cent-a-ton drop at commercial plants prompted the decline. At 367 commercial operations, 88 million tons of sand and gravel were prepared and sold for an average price of $1.19 a ton. Pit-run material brought 84 cents a ton. Of the 367 operations, 22 produced over 1 million tons each, 39 were in the 500,000 to 1 million ton range, 104 produced between 100,000 and 500,000 tons, and 202 produced less than 100,000 tons each.

Production of ground and unground industrial sands was 5 percent above the 1962 figure, with output increases reported for glass, molding, furnace, filtration, and filler uses. Outputs of all other specialty sands declined slightly.

TABLE 15.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Sand		Gravel		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	28,953	$31,370	48,041	$51,401	76,994	$82,771
1959	34,101	41,583	53,844	67,326	87,945	108,909
1960	36,524	46,000	51,155	61,503	87,679	107,503
1961	42,379	51,080	67,802	73,031	110,181	124,111
1962	47,463	54,293	60,197	70,629	107,660	124,922
1963	47,831	53,658	64,354	74,520	112,185	128,178

TABLE 16.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Glass	676	$3,491	720	$3,494
Molding	26	116	39	179
Building	23,077	27,024	22,825	25,615
Paving	11,140	11,778	11,864	12,200
Blast	212	767	145	346
Engine	55	178	47	140
Filter	9	54	22	92
Other	3,880	3,504	4,364	4,185
Total	39,075	46,912	40,026	46,251
Gravel:				
Building	23,262	29,566	25,574	30,639
Paving	23,984	28,875	24,789	29,702
Railroad ballast	398	418	484	499
Other	1,853	1,752	2,960	2,965
Total	49,497	60,611	53,807	63,805
Total sand and gravel	88,572	107,523	93,833	110,056
Government-and-contractor operations: [1]				
Sand:				
Building	59	77	200	220
Paving	7,615	6,681	6,977	6,715
Fill	707	614	623	468
Other	7	9	4	4
Total	8,388	7,381	7,804	7,407
Gravel:				
Building	2,576	2,046	2,057	2,073
Paving	7,486	7,494	7,570	7,812
Fill	532	368	832	666
Other	106	110	89	164
Total	10,700	10,018	10,548	10,715
Total sand and gravel	19,088	17,399	18,352	18,122
All operations:				
Sand	47,463	54,293	47,831	53,658
Gravel	60,197	70,629	64,354	74,520
Grand total	107,660	124,922	112,185	128,178

[1] Includes figures for States, counties, municipalities, and other Government agencies.

TABLE 17.—Sand and gravel production in 1963, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Alameda	9,898	$12,410	Plumas	366	$462
Butte	3,478	3,572	Riverside	2,588	4,383
Calaveras	94	149	Sacramento	5,390	7,303
Colusa	181	195	San Benito	370	491
Contra Costa	290	268	San Bernardino	7,212	6,749
Del Norte	503	551	San Diego	5,060	8,631
El Dorado	590	745	San Joaquin	2,773	3,487
Fresno	2,812	2,709	San Luis Obispo	563	720
Glenn	470	498	Santa Barbara	1,625	1,786
Humboldt	1,558	1,817	Santa Clara	3,212	2,595
Imperial	932	955	Santa Cruz	871	1,037
Inyo	86	121	Shasta	899	1,048
Kern	2,628	3,013	Sierra	241	206
Kings	2,084	1,869	Siskiyou	252	260
Lake	355	267	Solano	326	366
Lassen	214	217	Sonoma	2,351	2,985
Los Angeles	26,742	25,684	Stanislaus	1,006	1,077
Madera	388	361	Tehama	500	485
Mariposa	41	69	Trinity	236	200
Mendocino	1,181	1,586	Tulare	1,625	1,830
Merced	1,587	1,792	Tuolumne	13	14
Mono	121	144	Ventura	3,192	4,059
Monterey	943	1,797	Yolo	1,725	2,277
Napa	81	115	Yuba	557	803
Nevada	738	1,873	Other counties [1]	1,824	3,292
Orange	9,097	8,390	Total	112,185	128,178
Placer	316	465			

[1] Includes Alpine, Amador, Marin, Modoc, San Francisco, San Mateo and Sutter Counties, combined to avoid disclosing individual company confidential data.

Slag (Iron-Blast-Furnace).—Slag was generated in the blast furnaces at the Fontana plant of Kaiser Steel Corp. Except for the tonnage expanded for lightweight concrete aggregate by Kaiser's North Hollywood Block Division, the slag was prepared for various uses by Mineral Wool Insulations Division, American Gypsum Co., at Fontana. The granulated slag was sold for use as roofing granules, railroad ballast, sewage filter medium, fill, paving material, filler in fertilizers, and in the manufacture of mineral wool insulation.

Sodium Compounds.—Except for Glauber's salt and anhydrous sodium sulfate, production declines were reported for sodium compounds. Sodium carbonates recorded the most significant drop as sales were lost to the natural compounds produced in Wyoming. Pittsburgh Plate Glass Co. produced sodium carbonate and sesquicarbonate from Owens Lake brines, Inyo County. American Potash & Chemical Corp. and Stauffer Chemical Co. produced sodium carbonates and sulfates from Searles Lake brines, San Bernardino County. U.S. Borax & Chemical Corp. produced anhydrous sodium sulfate in its Wilmington refinery, Los Angeles County, from crude borates mined by the company in Kern County. Stauffer Chemical recovered byproduct sodium sulfate from purchased Kern County borates in its San Francisco plant.

Stone.—Stone production rose to nearly 38 million tons, 3 million tons more than in 1962 and a greater tonnage than in any year except 1957. The value of the 1963 output was an alltime record of $58 million. Significant tonnages were quarried for fill, base course, and concrete aggregate as well as for use in water, power, levee and harbor projects. Outputs of dimension stone for rubble and crushed stone for riprap were below 1962 figures, primarily because of extensive substitution of old dredge tailings in Butte County dam construction. Large volumes of unclassified miscellaneous stone were quar-

ried in Alameda County for fill, in Calaveras County for a dam, in Riverside County for riprap, and in Santa Clara County for base material. Greater quantities of basalt were produced for base course and aggregate in Marin, Napa, and Sonoma Counties. Less granite was quarried for riprap but the tonnage of dimension granite for monumental, building, and surface plate uses were appreciably higher than in 1962. In San Benito and Santa Cruz Counties larger tonnages of crushed and decomposed granite were mined.

Quarries in San Bernardino and Santa Clara Counties contributed greatly to the State's total limestone output, which was nearly 8 percent above 1962. Most of the gain was in limestone quarried for use in making cement and for road construction. Notable increases also were reported throughout the State for making lime and for use in sugar refining, glass manufacture, whiting, and industrial fillers. The tonnages of dimension marble for building stone and crushed marble for terrazzo were higher, but output of crushed marble for roofing granules declined. Production of standstone, quartz, and quartzite rose for use in cement, as road base and exposed aggregate, and for dimension building stone.

Natural and artificially colored roofing granules, prepared from crushed stone, gravel, slag, and volcanic cinder, totaled 488,000 tons, an increase of 1,000 tons compared with 1962.

TABLE 18.—Stone sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction and rubble—short tons	168,986	$935,180	139,461	$1,268,071
Rough architectural—cubic feet	(1) (2)	(1) (2)	183,542	1,146,045
Approximate equivalent in—short tons	(1) (2)		15,013	
Monuments and mausoleums—cubic feet	112,569	1,020,649	59,260	440,000
Approximate equivalent in—short tons	9,371		4,940	
Flagging—cubic feet	53,593	100,355	26,253	66,083
Approximate equivalent in—short tons	4,541		2,219	
Total dimension stone approximate, in short tons	182,898	2,056,184	161,633	2,920,199
Crushed and broken stone:				
Riprap—short tons	3,970,336	7,240,417	2,285,809	4,700,367
Metallurgical—do	(3)	289,830	(3)	(3)
Concrete and roadstone—do	13,061,251	16,486,880	14,191,863	18,348,016
Railroad ballast—do	(3)	(3)	(3)	(3)
Agricultural—do	(3)	(3)	(3)	(3)
Chemical—do	28,500	338,226	34,276	307,482
Miscellaneous [4]—do	[5] 17,533,387	[5] 28,310,555	[6] 21,303,459	[6] 31,976,980
Total crushed and broken stone—do	34,593,474	52,665,908	37,815,407	55,332,845
Grand total approximate, in short tons	34,776,372	54,722,092	37,977,040	58,253,044

[1] Includes dressed architectural, roofing slate, and mill stock.
[2] Included with monuments and mausoleums to avoid disclosing individual company confidential data.
[3] Included with "Miscellaneous" to avoid disclosing individual company confidential data.
[4] Includes whiting substitute, filler, mineral food, poultry grit, stucco, roofing granules, filter beds, terrazzo, metallurgical, railroad ballast, agricultral, chemical, and miscellaneous uses.
[5] Includes 12,216,045 short tons of limestone and oystershell used in cement valued at $13,733,543 and 582,466 tons of limestone used in lime valued at $1,659,642.
[6] Includes 12,572,059 short tons of limestone and oystershell used in cement valued at $11,553,145 and 670,187 tons of limestone used in lime valued at $2,027,035.

TABLE 19.—Stone [1] production in 1963, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Alameda	1,974	$2,188	Plumas	(2)	$10
Amador	(2)	(2)	Riverside	1,389	3,451
Butte	70	70	Sacramento	2	5
Calaveras	4,649	6,357	San Benito	(2)	(2)
Contra Costa	2,829	4,490	San Bernardino	5,450	8,194
Del Norte	90	100	San Diego	1,130	1,827
El Dorado	582	1,727	San Francisco	(2)	(2)
Fresno	216	578	San Luis Obispo	209	1,018
Glenn	4	10	San Mateo	2,076	2,762
Humboldt	309	423	Santa Barbara	588	883
Imperial	28	32	Santa Clara	4,919	3,508
Inyo	143	676	Santa Cruz	1,321	1,795
Kern	2,898	3,423	Shasta	468	495
Kings	155	259	Sierra	(2)	(2)
Lassen	14	17	Siskiyou	167	288
Los Angeles	1,908	3,612	Solano	65	122
Madera	13	(2)	Sonoma	264	378
Marin	(3)	(2)	Tehama	29	43
Mariposa	6	27	Trinity	39	36
Mendocino	70	128	Tulare	110	362
Modoc	(3)	(4)	Tuolumne	191	1,038
Mono	(3)	(4)	Ventura	332	948
Monterey	(2)	(2)	Yuba	3	6
Napa	(2)	(2)	Other counties [5]	3,232	6,883
Orange	16	13			
Placer	19	71	Total	37,977	58,253

[1] Includes stone used in cement and lime.
[2] Included with "Other counties" to avoid disclosing individual company confidential data.
[3] Less than 500 short tons.
[4] Less than $500.
[5] Includes Amador, Marin, Monterey, Napa, San Benito, San Francisco, and Sierra.

TABLE 20.—Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Granite		Basalt and related rocks (traprock)		Limestone [1]	
	Quantity	Value	Quantity	Value	Quantity	Value
1959	4,343	$5,433	1,772	$2,728	16,137	$24,384
1960	4,208	5,409	1,941	2,748	15,054	23,311
1961	4,867	7,233	1,880	2,225	16,669	23,989
1962	4,484	5,975	1,886	2,200	15,694	24,082
1963	3,814	6,098	2,024	2,801	16,447	22,806

Year	Sandstone		Otherstone [2]		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1959	2,758	$4,506	7,124	$12,039	32,134	$49,090
1960	3,541	5,626	8,331	12,748	33,075	49,842
1961	3,286	5,222	7,148	11,658	33,850	50,327
1962	2,399	4,038	10,313	18,427	34,776	54,722
1963	3,363	5,898	12,329	20,650	37,977	58,253

[1] Includes limestone and oystershell used in cement and lime as follows (in thousand short tons and thousand dollars): 1959, 13,663 tons, $16,628; 1960, 12,605 tons, $16,645; 1961, 12,778 tons, $15,312; 1962, 12,799 tons, $15,393; 1963, 13,242 tons, $13,580.
[2] Includes light-colored volcanics, schist, serpentine, river boulders, and such other stone as cannot properly be classed in any main group; also marble and slate.

Sulfur.—Elemental sulfur (brimstone) was recovered from sour natural and refinery gases as a byproduct of petroleum refining in six California plants—two in Contra Costa County, three in Los Angeles County, and one in San Luis Obispo County. The processes used to recover the brimstone were combinations of the Girbotol process or the diethanolamine absorption process in conjunction with the Klaus

process or some modification thereof. Production and shipments of brimstone rose 8 and 14 percent, respectively, above the 1962 figures.

Several hundred tons of sulfur ore was mined from the Inyo County Crater Sulphur deposit by Inyo Soil Sulphur Co. and from the Lake County S Bar S mine by American Mineral Resources Development Co. The outputs were shipped for use as a soil aid. All other sulfur properties were idle throughout the year.

Talc, Soapstone, and Pyrophyllite.—Crude talc was shipped from 12 mines in San Bernardino County and from 11 mines in Inyo County (a twelfth shipped from stockpile); soapstone from two properties in Amador County and one property each in El Dorado and Los Angeles Counties; and pyrophyllite from three mines in San Diego County, two in Mono County, and one in San Bernardino County. Production and shipments to grinders rose 2 and 4 percent, respectively. Crude sales to consumers, though relatively small, increased 69 percent compared with 1962. Consumption of ground minerals declined 4 percent and of the total, 49 percent was used by the ceramic industry, 20 percent in paints, 9 percent in insecticides, and 19 percent by the rubber, cosmetic, rice polishing, textile, paper, and other industries. About 3 percent of the total was exported, all but 1 ton of which was talc.

Vermiculite.—Exfoliation plants were operated in Sacramento and Los Angeles Counties by California Zonolite Co., on crude vermiculite received from company mines in Montana. South African crude was imported by LaHabra Products, Inc. (formerly Lahabralite Co.) and exfoliated in an Orange County plant. Plant products were used for acoustical and thermal insulation, consumed as aggregate in plaster and concrete, and used as a soil conditioner. Demand for the products rose in all categories.

Water.—Thirty-one water-consuming agencies, representing 63 percent of the State's population, had contracted by yearend with the California Central Valley Water Project for the delivery of more than 85 percent of the total project yield in acre feet. The concrete core block of Oroville dam was completed and the 4-year project of transporting and placing 155 million tons of dredge tailing was begun. Construction was also started on the California aqueduct, designed to carry water through the San Joaquin Valley to southern California.

Other Nonmetals.—Shipments of phosphate rock averaging nearly 32 percent phosphorus pentoxide, purchased from Idaho and Wyoming mines by California producers of chemicals and fertilizers, were 20 percent more than in 1962. Collier Carbon & Chemical Corp. reported no action by the Bureau of Land Management on its 1962 request for return of payment on an offshore lease covering 30,000 acres of phosphoric nodule deposits. Collier contended the acreage was contaminated with unexploded Naval ordnance material.

C. K. Williams Co., Alameda County, was the only producer of finished natural and manufactured iron oxide pigments. Although most of the plant output was manufactured red, yellow, brown and black oxides, the company also used out-of-State raw materials to produce natural brown and red oxides, Venetian red, ocher, sienna and umber (burnt and raw) and Vandyke brown.

No activity was reported at a San Diego County celestite deposit, at Inyo County garnet claims, or at a San Bernardino amorphous silica property. Two operators in Riverside County collected and shipped wollastonite float for landscaping and building construction.

747-416—64——13

METALS

Beryllium.—Gem beryl was collected in the Pala district, San Diego County. Other 1963 activity was limited to assessment work at the Ruby claims near Jacumba in the Tule Mountains of San Diego County.

Copper.—There were no active copper mines in 1963. Except for relatively small quantities of recoverable copper contained in silver ore mined in Alpine County, gold ore produced in Yuba County, and lead and lead-zinc ores from Inyo County mines, all recoverable copper was obtained as a byproduct in processing tungsten ore at the Pine Creek mine, Inyo County. Total recovered metal was substantially below that in 1962.

Gold.—Gold production declined 18 percent from that of 1962. Despite a 14-percent drop in placer output, gold recovered from placers represented 95 percent of the total. One bucketline dredging operation (4 dredges), 3 dragline excavating and sluicing operations, and 19 nonfloating washing plants recovered 96 percent of the placer gold. All but three of the nonfloat plants were sand and gravel preparation plants where placer gold was recovered as a byproduct.

Lode gold recovery dropped 63 percent. There were 15 fewer lode gold mines operating than in 1962. The Original 16 to 1 mine, Sierra County, suspended operations early in the year. The mine had been in operation for more than a half-century and a leading lode-gold producer since World War II. Ores of four mines—one silver (Zaca, Alpine County) and three gold (Original 16 to 1 and Brush Creek, Sierra County, and Dannebroge, Yuba County) yielded 64 percent of all lode gold recovered. At only five other lode mines—four gold and one tungsten—was more than 100 ounces of gold produced during 1963.

TABLE 21.—Mine production of gold, silver, copper, lead, and zinc in 1963, by counties, in terms of recoverable metals

County	Mines producing [1]		Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Troy ounces	Value	Troy ounces	Value
Amador		1	159	$5,565	17	$22
Butte	2	4	235	8,225	54	69
Calaveras	2	1	53	1,855	3	3
El Dorado	1	1	154	5,390	15	19
Fresno		[2]	361	12,635	50	64
Imperial	2		13	455	7	9
Inyo	6		262	9,170	126,042	161,223
Kern	3		63	2,205	25	31
Lassen		[2]	1	35		
Madera	1	1	81	2,835	20	26
Mariposa	3	2	312	10,920	[3]	[3]
Merced		[2]	92	3,220	8	10
Monterey	1		3	105	1	1
Nevada	3	14	800	28,000	67	86
Placer	1	5	121	4,235	12	16
Plumas		5	93	3,255	3	4
Sacramento		[2]	432	15,120	30	38
San Bernardino	5		64	2,240	105	134
San Joaquin		[2]	18	630	3	4
Shasta	3	1	116	4,060	19	24
Sierra	6	12	2,130	74,550	391	500
Siskiyou		8	1,155	40,425	188	240
Stanislaus		[2]	69	2,415	7	9
Tehama		[2]	1	35		
Trinity	2	14	292	10,220	30	39
Tuolumne	4	2	200	7,000	19	25
Undistributed [4]	5	8	79,587	2,785,545	29,412	37,622
Total	50	79	86,867	3,040,345	156,528	200,218

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Amador							$5,587
Butte							8,294
Calaveras							1,858
El Dorado							5,409
Fresno							12,699
Imperial							464
Inyo	[3]	[3]	1,637,300	$176,828	[3]	[3]	347,221
Kern							2,236
Lassen							35
Madera							2,861
Mariposa							10,920
Merced							3,230
Monterey							106
Nevada							28,086
Placer							4,251
Plumas							3,259
Sacramento							15,158
San Bernardino			1,700	184			2,558
San Joaquin							634
Shasta							4,084
Sierra							75,050
Siskiyou							40,665
Stanislaus							2,424
Tehama							35
Trinity							10,259
Tuolumne							7,025
Undistributed	1,832,000	$564,256	7,000	756	202,000	$23,230	3,411,409
Total	1,832,000	564,256	1,646,000	177,768	202,000	23,230	4,005,817

[1] Excludes itinerant prospectors, "snipers," "high-graders," and others who gave no evidence of legal right to property.
[2] From property not classed as a mine.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Includes Alpine, Humboldt, Los Angeles, and Yuba Counties and counties indicated by footnote 3.

TABLE 22.—Gold produced at placer mines, by classes of mines and methods of recovery [1]

Class and method	Mines producing [2]	Number of washing plants (dredges)	Material treated (thousand cubic yards)	Gold recovered		
				Troy ounces	Value	Average value per cubic yard
Surface placers:						
Gravel mechanically handled:						
Bucketline dredges:						
1954–1958 (average)	3	10	36,127	132,129	$4,624,529	$0.132
1959	2	7	24,528	103,023	3,605,805	.147
1960	2	5	21,020	89,562	3,134,670	.149
1961	2	5	23,651	82,316	2,881,060	.122
1962	(3)	(3)	(3)	(3)	(3)	(3)
1963	(3)	(3)	(3)	(3)	(3)	(3)
Dragline dredges: [4]						
1954–1958 (average)	7	7	197	830	29,064	.167
1959	6	6	119	1,405	49,175	.413
1960	13	14	111	1,081	37,835	.340
1961	3	3	493	309	10,815	.022
1962	(3)	(3)	(3)	(3)	(3)	(3)
1963	(3)	(3)	(3)	(3)	(3)	(3)
Suction dredges:						
1954–1958 (average)	2	2	6	28	980	.306
1959	3	3	7	68	2,380	.359
1960	2	2	(5)	5	175	.583
1961	5	5	64	22	770	.012
1962	(3)	(3)	(3)	(3)	(3)	(3)
1963	(3)	(3)	(3)	(3)	(3)	(3)
Nonfloating washing plants: [4 6]						
1954–1958 (average)	14	20	21	1,642	57,456	2.565
1959	3	11	2	1,201	42,035	.326
1960	2	6	8	365	12,775	.376
1961	6	9	340	557	19,495	.039
1962	(3)	(3)	(3)	(3)	(3)	(3)
1963	(3)	(3)	(3)	(3)	(3)	(3)
Gravel hydraulically handled:						
1954–1958 (average)	7	----	37	163	5,719	.348
1959	3	----	4	50	1,750	.417
1960	4	----	1	11	385	.396
1961	2	----	2	3	105	.050
1962	(3)	(3)	(3)	(3)	(3)	(3)
1963	(3)	(3)	(3)	(3)	(3)	(3)
Small-scale hand method: [7]						
1954–1958 (average)	34	----	75	1,294	45,311	.702
1959 [8]	22	----	30	1,146	40,110	1.405
1960 [8]	26	----	59	1,111	38,885	.617
1961	27	----	17	1,105	38,675	.324
1962	(3)	----	(3)	(3)	(3)	(3)
1963	(3)	----	(3)	(3)	(3)	(3)
Underground placers: Drift:						
1954–1958 (average)	10	----	3	140	4,900	1.565
1959	3	----	(5)	9	315	1.432
1960	1	----	1	44	1,540	1.750
1961	3	----	1	55	1,925	1.250
1962	(3)	----	(3)	(3)	(3)	(3)
1963	(3)	----	(3)	(3)	(3)	(3)
Grand total placers:						
1954–1958 (average)	77	----	36,466	136,226	4,767,959	.131
1959	42	----	24,691	106,902	3,741,570	.152
1960	50	----	21,201	92,179	3,226,265	.152
1961	48	----	24,570	84,367	2,952,845	.119
1962	37	----	18,272	95,918	3,357,130	.182
1963	79	----	13,133	82,998	2,904,930	.221
1848–1963	----	----	(9)	68,226,553	1,523,667,001	(9)

[1] For historical data by years, see Minerals Yearbook, Review of 1940, p. 219.
[2] Excludes itinerant prospectors, "snipers," "high-graders," and others who gave no evidence of legal right to property.
[3] Concealed to avoid disclosing individual company data.
[4] Includes commercial rock plants and tungsten mines that produced byproduct gold from gravels; byproduct gold is included with gold recovered, but material treated and average value per cubic yard refer only to straight gold dredging.
[5] Less than 1,000 cubic yards.
[6] Includes all placer operations using power excavator and washing plants both on dry land; when the washing plant is a movable outfit, it is termed "dryland dredge."
[7] Includes all operations in which hand labor is principal factor in delivering gravel to sluices, long toms.
[8] Includes gold recovered by electrostatic separation; combined to avoid disclosing individual company confidential data.
[9] Data not available.

TABLE 23.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mine producing [2]		Material sold or treated [3] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousand dollars)	Troy ounces	Value (thousand dollars)
1954–58 (average)	120	77	232	207,942	$7,278	582,489	$527
1959	73	42	142	145,270	5,084	172,810	156
1960	83	50	157	123,713	4,330	179,780	163
1961	79	48	46	97,644	3,418	93,351	86
1962	65	37	43	106,272	3,720	132,505	144
1963	50	79	21	86,867	3,040	156,528	200
1848–1963	-------	-------	(4)	105,995,430	2,411,943	119,306,764	97,277

Year	Copper		Lead		Zinc		Total value (thousand dollars)
	Short tons	Value (thousand dollars)	Short tons	Value (thousand dollars)	Short tons	Value (thousand dollars)	
1954–58 (average)	706	$473	4,766	$1,427	3,864	$978	$10,683
1959	663	407	227	52	78	18	5,717
1960	1,087	698	440	103	465	120	5,414
1961	1,382	829	103	21	304	70	4,424
1962	1,162	716	455	84	322	74	4,737
1963	916	564	823	178	101	23	4,005
1848–1963	640,848	209,668	264,699	52,624	150,676	35,569	2,807,081

[1] Includes recoverable metal content of gravel washed (placer operations); ore milled; old tailings or slimes retreated; tungsten ore; and ore, old tailings, slag, flue dust, and pyritic ore residue shipped to smelters during calendar year indicated.
[2] Excludes itinerant prospectors, "snipers," "high-graders," and others who gave no evidence of legal right to property.
[3] Does not include gravel washed.
[4] Data not available.

TABLE 24.—Mine production of gold, silver, copper, lead, and zinc in 1963, by types of material processed and methods of recovery, in terms of recoverable metals [1]

Type of material processed, and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Amalgamation:					
Ore	2,214	411	-------	-------	-------
Old tailings	12	11	-------	-------	-------
Total	2,226	422	-------	-------	-------
Concentration and smelting of concentrates: Ore [1 2]	1,535	91,125	1,820,300	7,000	8,700
Direct smelting: Ore	108	60,137	11,700	1,639,000	193,300
Placer	82,998	4,844	-------	-------	-------
Grand total	86,867	156,528	1,832,000	1,646,000	202,000

[1] Includes gold recovered as "natural gold."
[2] Includes tungsten-ore concentrate.

TABLE 25.—Mine production of gold, silver, copper, lead, and zinc in 1963, by classes of ore or other source materials in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Gold	42	11,561	2,946	691	100		
Silver	2	2,510	718	24,869	900	6,500	6,200
Copper and tungsten ore [2]	1	[3] 2,000	134	66,007	1,819,300	500	2,500
Lead	4	1,294	22	24,397	1,600	872,200	3,600
Lead-zinc	1	3,043	34	35,707	10,100	766,800	189,700
Total	50	20,408	3,854	151,671	1,832,000	1,646,000	202,000
Other lode material: Old tailings	([4])	200	15	13			
Total lode material	50	20,608	3,869	151,684	1,832,000	1,646,000	202,000
Placer	79	([5])	82,998	4,844			
Total all sources	129	20,608	86,867	156,528	1,832,000	1,646,000	202,000

[1] Detail will not necessarily add to total, because some mines produce more than one class of material.
[2] Combined to avoid disclosing individual company confidential data.
[3] Tungsten-ore tonnage not included.
[4] From property not classed as a mine.
[5] 13,132,964 cubic yards. Does not include material washed at commercial gravel plants to produce 1,315 ounces of by-product gold and 140 ounces of by-product silver included in placer totals.

Iron Ore.—Production and shipments of usable iron ore rose 34 and 43 percent, respectively. Over 98 percent of all shipments were concentrates. The gain in tonnage shipped resulted from a sharp increase in exports to Japan and a strong demand by domestic furnaces throughout the year. Six iron properties were active all or part of the year, two each in Riverside and San Bernardino Counties and one each in Inyo and Shasta Counties. About 71 percent of the production was consumed by the domestic iron and steel industry, 28 percent was exported to Japan, and the remainder was used in cement. Kaiser Steel Corp. announced it had contracted with Japanese steel interests to produce and ship 6 million tons of iron ore pellets from its Eagle Mountain facility at the rate of 1 million tons a year, beginning in 1965.

In San Bernardino County, American Exploration and Mining Co. conducted intensive stripping in preparation for increased production from the Iron Age mine. In Shasta County, metallurgical testing was conducted on ores from the Shasta and California properties.

Iron and Steel Scrap.—Overall iron and steel scrap consumption rose more than 7 percent. Use at steel furnaces increased 8 percent and that of iron foundries 6 percent. The steel furnaces of Kaiser Steel Corp. at Fontana and U.S. Steel Corp. at Pittsburg and Torrance charged pig iron as well as home-generated and purchased scrap. All other California steel furnaces charged 100-percent scrap. Both home-generated and purchased scrap rose more than 8 percent from 1962. Yearend scrap prices averaged higher than at the same time a year earlier, particularly for customer-delivered No. 1 and No. 2 heavy melting and No. 1 and No. 2 dealer bundles at San Francisco. In 1962, exports of iron and steel scrap were less than half the 1961 tonnage. The 1963 tonnage was less than half that of 1962.

TABLE 26.—Ferrous scrap and pig iron consumption

(thousand short tons)

Year	Ferrous scrap	Pig iron	Year	Ferrous scrap	Pig iron
1954–58 (average)	2,507	1,274	1961	2,250	2,192
1959	2,280	1,379	1962	2,248	1,818
1960	2,054	1,650	1963	2,415	1,819

TABLE 27.—Ferrous scrap and pig iron consumption by types of furnaces and miscellaneous uses

(Thousand short tons)

Ferrous scrap and pig iron charged to—	1962	1963	Ferrous scrap and pig iron charged to—	1962	1963
Steel furnaces: [1]			Miscellaneous uses: [3] Scrap	46	41
Scrap	1,867	2,019	Total scrap	2,248	2,415
Pig iron	1,600	1,710	Total pig iron	1,818	1,891
Total	3,467	3,729	Grand total	4,066	4,306
Iron furnaces: [2]					
Scrap	335	355			
Pig iron	218	181			
Total	553	536			

[1] Includes open hearth, electric furnace, and basic oxygen process.
[2] Includes cupola, air, and blast furnaces; also direct castings.
[3] Includes rerolling, copper precipitation, nonferrous, and chemical uses.

Lead.—Except for comparatively minor quantities of recoverable lead contained in silver ore mined in Alpine County, and a few tons of lead ore shipped from the C&K prospect in San Bernardino County, production of lead came from one lead-zinc mine (Santa Rosa) and three lead mines (Defense, Jubilee and Bunker Hill) in Inyo County. However, total lead recovered was nearly 81 percent above that of 1962.

Manganese.—The Pioneer manganese mine was idle in 1963 but the owner was negotiating at yearend to ship stockpiled concentrate to a Nevada consumer and/or an Arizona broker.

Mercury.—Nearly 22 percent less ore was treated and 15 percent fewer flasks of mercury recovered than in 1962. Shipments declined 18 percent. Only four mines reported output of 100 flasks or more—New Idria, San Benito County; Buena Vista, San Luis Obispo County; New Almaden, Santa Clara County; and Culver-Bear, Sonoma County. Although 31 mercury properties contributed to production, the combined output of the above 4 mines was 97 percent of the total.

TABLE 28.—Mercury production, by methods of recovery

Year	Operating mines	Recovery method					Total	
		Furnaced [1]		Retorted		Unclassified		
		Ore treated (short tons)	76-pound flasks	Ore treated (short tons)	76-pound flasks	76-pound flasks [2]	76-pound flasks	Value [3]
1954–58 (average)	52	111,175	12,043	9,334	1,519	244	13,806	$3,477,856
1959	37	107,072	15,685	12,034	1,271	144	17,100	3,889,908
1960	41	120,714	17,862	4,334	785	117	18,764	3,954,701
1961	36	118,264	17,776	2,431	883	29	18,688	3,692,936
1962	37	79,948	15,407	3,728	496	48	15,951	3,049,991
1963	31	61,595	13,273	4,068	303	16	13,592	2,575,004

[1] Includes ore and mercury from dumps not separable.
[2] Includes mercury recovered from miscellaneous dump material, placer, and cleanup operations.
[3] Value calculated at average New York price.

Molybdenum.—Molybdenite and powellite were produced by Union Carbide Nuclear Co. as byproducts in mining and processing tungsten ores from the Pine Creek mine, Inyo County. Production and shipments of the two minerals (combined) rose 25 and 14 percent, respectively. Shipments were made to both domestic and foreign customers.

Pig Iron.—Blast furnaces at the integrated steel plant of Kaiser Steel Corp., San Bernardino County, produced all the State's pig iron. Although some foundry pig was sold, the company consumed most of the basic pig in making steel. Comparatively small tonnages of pig iron were shipped to the Pittsburg, Contra Costa County, and Torrance, Los Angeles County, furnaces of United States Steel Corp. The company's open-hearth furnaces at Pittsburg were shut down in February, and broken molds and stods were substituted for pig iron at Torrance for more than half the year. Despite these apparent adversities, production, consumption, and shipments rose 7, 4, and 9 percent, respectively, above the 1962 figures.

Platinum-Group Metals.—Yuba Consolidated Gold Fields reported the byproduct recovery of the platinum-group metals by its Yuba Unit, using a bucketline dredge to work stream gravels and ancient river beds for placer gold along the Yuba River near Marysville.

Rare-Earth Minerals.—Production of bastnaesite concentrate at the Molybdenum Corporation of America Mountain Pass operation, San Bernardino County, was lower in 1963 but shipments increased substantially. The company installed additional plant facilities at York, Pa., to make rare-earth chlorides from the bastnaesite concentrate to enable entry into the European market at prices for rare-earth chemicals that can compete with those of that market. The increased shipments of bastnaesite concentrate from Mountain Pass resulted from growth in demand for rare earths used in the production of ductile iron and establishment of a new market as a polishing material for flat glass.

Silver.—Ores from five lode mines—one silver (Zaca) in Alpine County; one lead-zinc (Santa Rosa), one tungsten (Pine Creek), and two lead (Defense and Jubilee) all four in Inyo County—yielded 99 percent of the recoverable lode silver and 96 percent of all silver recovered in 1963. Lode silver production rose 19 percent, whereas placer silver (coproduct recovery in placer gold mining) output

dropped 11 percent compared with 1962. The higher average unit price for silver was not a stimulus to placer mining.

Tin.—The Meeke-Hogan (Hogan-Mallery) tin mine near Gorman, Kern County, was leased from Tejon Ranch Co. by American Tin Corp. which mined and concentrated tin ore during 1963. The concentrate was sold to Federated Metals Div., American Smelting & Refining Co., San Francisco.

Tungsten.—The Pine Creek mine in Inyo County of Union Carbide Nuclear Co. was the only active tungsten property in California. The company also purchased tungsten concentrates from Idaho and Nevada producers and from eastern sources. Some of the produced and purchased concentrates were converted to ammonium paratungstate in the producer's plant. The company shipped concentrates and the plant product to customers throughout the United States and Canada. Total shipments declined more than 7 percent from 1962.

The Strawberry mine and mill in Madera County of New Idria Mining and Chemical Co. was idle throughout the year. Only one other tungsten property, the Big Sugar mine in Kern County, reported activity during the year, principally assessment work.

Uranium.—Production and shipments of uranium ore were reported for the first time since 1960. Humbug Development Co. from its deposit in Riverside County, and Garn L. Moody from the Juniper claims in Tuolumne County shipped ore to the Vitro Chemical Co. processing plant in Salt Lake City, Utah.

Zinc.—Zinc production dropped to less than one-third compared with that of 1962. Only three mines shipped ore containing recoverable zinc—the Zaca mine (silver ore) in Alpine County and the Santa Rosa (lead-zinc ore) and Jubilee (lead) mines, both in Inyo County.

Other Metals.—No activity was reported at chromite mines and prospects. Assessment work only was performed at nickel-cobalt claims in Del Norte, Imperial, and San Diego Counties; at ilmenite and rutile claims in Trinity County; and at zirconium-hafnium claims in Kern County.

The first shipment of rutile concentrate for the Antioch titanium dioxide plant of E. I. du Pont de Nemours & Co., Inc., in Contra Costa County, arrived from Australia on September 30. American Potash & Chemical Corp. stated that a titanium dioxide plant originally scheduled for Mojave, Kern County, would be built in Mississippi instead.

REVIEW BY COUNTIES

Alameda.—Nearly 10 million tons of sand and gravel and 2 million tons of stone were produced for concrete aggregate and base material, used principally in building construction. Dredges in San Francisco Bay and pits in the Fremont, Pleasanton, Livermore, Sunol, and San Leandro areas supplied most of the sand and gravel for construction. Production increased 19 percent over that of 1962. Output of stone for riprap, road base, and fill, obtained from quarries near Hayward, San Leandro, Sunol, and Oakland, was 35 percent above that of 1962. Appreciable tonnages of stone and sand and gravel also were used in streets and highways, particularly the State's large-scale highway construction projects. Peter Kiewit & Sons opened a new stone quarry near Sunol. Gallagher & Burk, Inc., installed a new stone processing plant in Oakland near its Leona basalt quarry.

Crude salt was harvested from several thousand acres of evaporating ponds by Leslie Salt Co. and processed in four company plants. Oliver Bros. Salt Co. operated a plant at Mt. Eden. Leslie supplied the Morton Salt Co. refinery with crude salt and sold saltwork bitterns from its Newark plant to FMC Corp. for extraction of magnesium hydroxide and bromine. FMC used dolomite from its San Benito quarry to make lime used in the process and byproduct gypsum, which it sold for use as a cement retarder. Gypsum from Nevada was calcined by Fibreboard Paper Products Corp. in its Newark plant for use in making wallboard. The Flintkote Co. planned to build a new gypsum products plant at Fremont. Holly Sugar Co. calcined purchased limestone at Alvarado to obtain carbon dioxide and lime used in sugar refining. E. H. Metcalf mined miscellaneous clay near Livermore and sold it for use in making brick. Interlocking Roof & Tile Co. and Kraftile Co. mined clays near Niles for use in roofing products and ceramic tile. Fibreboard purchased magnesia for its Emeryville insulation plant. Philadelphia Quartz Co. made hydrous magnesium sulfate from magnesite purchased in Nevada. C. K. Williams Co. produced natural and synthetic iron oxide pigments in its Emeryville plant. Raw materials for the natural pigments were obtained out-of-State.

Pacific States Steel Corp. in Union City and Judson Steel Corp. in Emeryville used iron and steel scrap as the sole metal source for open-hearth steel furnace operations.

TABLE 29.—Value of mineral production in California, by counties

County	1962	1963	Minerals produced in 1963 in order of value
Alameda	$21,163,869	$21,965,035	Sand and gravel, salt, stone, magnesium compounds, lime, bromine, clays.
Alpine	(1)	130,181	Sand and gravel, silver, gold, zinc, lead, copper.
Amador	2,355,271	2,346,267	Sand and gravel, clays, coal (lignite), stone, gold, soapstone, silver.
Butte	4,918,414	6,395,363	Sand and gravel, natural gas, stone, gold, silver.
Calaveras	15,956,574	20,576,319	Cement, stone, asbestos, clays, sand and gravel, gold, silver.
Colusa	4,330,091	4,802,471	Natural gas, sand and gravel, gem stones.
Contra Costa	4,640,618	7,586,743	Stone, natural gas, petroleum, sand and gravel, peat, clays.
Del Norte	347,395	651,615	Sand and gravel and stone.
El Dorado	3,427,639	3,112,911	Stone, sand and gravel, lime, soapstone, gem stones, gold, silver.
Fresno	[2] 87,325,931	80,622,498	Petroleum, natural gas, sand and gravel, natural gas liquids, asbestos, stone, gold, clays, mercury, silver, gem stones.
Glenn	5,799,925	5,867,456	Natural gas, sand and gravel, lime, stone, gem stones.
Humboldt	2,231,510	2,845,548	Sand and gravel, natural gas, stone, gold, gem stones.
Imperial	[2] 3,157,286	3,296,101	Gypsum, sand and gravel, lime, clays, stone, pumice, mica (scrap), gold, gem stones, silver.
Inyo	12,749,118	11,624,911	Tungsten, sodium carbonate, molybdenum, talc, stone, copper, lead, silver, pumice and volcanic cinder, sand and gravel, perlite, boron minerals, clays, zinc, gold, gem stones, iron ore, sulfur ore.
Kern	[2] 352,319,505	363,056,485	Petroleum, boron minerals, natural gas, cement, natural gas liquids, stone, sand and gravel, gypsum, sodium sulfate, salt, clays, carbon dioxide, pumice, mercury, tin, gem stones, gold, silver.
Kings	[2] 13,867,358	15,360,267	Natural gas, natural gas liquids, petroleum, sand and gravel, stone, gypsum, mercury.
Lake	397,371	443,690	Sand and gravel, pumice and volcanic cinder, mercury, sulfur ore, clays, gem stones.
Lassen	293,160	271,966	Sand and gravel, volcanic cinder, stone, gem stones, gold.
Los Angeles	[2] 262,245,038	271,468,189	Petroleum, sand and gravel, natural gas, natural gas liquids, stone, clays, iodine, gold, soapstone, gem stones, silver.
Madera	1,672,861	1,875,591	Stone, natural gas, sand and gravel, pumice and volcanic cinder, clays, gold, silver.

See footnotes at end of table.

TABLE 29.—Value of mineral production in California, by counties—Continued

County	1962	1963	Minerals produced in 1963 in order of value
Marin	$1,978,405	$2,701,934	Stone, sand and gravel, clays, mercury.
Mariposa	131,862	107,311	Sand and gravel, stone, gold, silver, gem stones.
Mendocino	748,620	1,714,950	Sand and gravel, stone, mercury, gem stones.
Merced	1,434,990	1,801,828	Sand and gravel, gypsum, gold, silver.
Modoc	967,696	646,418	Sand and gravel, peat, pumice, gem stones, stone.
Mono	1,388,087	1,065,660	Pumice, sand and gravel, clays, pyrophyllite, stone.
Monterey	[2] 29,544,234	28,324,431	Petroleum, lime, magnesium compounds, sand and gravel, stone, natural gas, feldspar, salt, gem stones, gold, silver.
Napa	2,356,009	2,232,547	Clays, stone, salt, sand and gravel, diatomite, asbestos, mercury, perlite, gem stones.
Nevada	631,661	1,901,044	Sand and gravel, gold, silver.
Orange	[2] 105,019,580	105,559,111	Petroleum, natural gas, sand and gravel, natural gas liquids, clays, lime, salt, stone, iodine, peat, gem stones.
Placer	1,314,457	984,034	Sand and gravel, clays, stone, gold, silver.
Plumas	[2] 297,346	475,243	Sand and gravel, stone, gold, gem stones, silver.
Riverside	[2] 36,980,898	48,528,626	Iron ore, cement, sand and gravel, stone, clays, gypsum, peat, uranium, wollastonite, petroleum, gem stones.
Sacramento	22,050,616	22,690,931	Natural gas, sand and gravel, clays, gold, stone, silver.
San Benito	[2] 8,346,829	8,218,359	Cement, mercury, stone, petroleum, sand and gravel, natural gas, clays, asbestos, gem stones.
San Bernardino	[2] 96,241,755	101,837,066	Cement, boron minerals, stone, sodium carbonate, sand and gravel, potassium salts, sodium sulfate, salt, clays, iron ore, talc and pyrophyllite, lime, calcium chloride, lithium, bromine, rare earths, petroleum, volcanic cinder, natural gas, gem stones, mica (scrap), gold, perlite, lead, silver.
San Diego	10,681,866	11,276,459	Sand and gravel, stone, magnesium compounds, salt, clays, pyrophyllite, gem stones.
San Francisco	[1]	[1]	Sand and gravel, stone.
San Joaquin	10,703,096	15,957,331	Natural gas, sand and gravel, lime, clays, gold, silver.
San Luis Obispo	[2] 7,225,643	6,451,448	Petroleum, stone, sand and gravel, natural gas liquids, mercury, natural gas, gypsum, clays, gem stones.
San Mateo	[2] 13,902,122	14,477,532	Cement, stone, magnesium compounds, salt, sand and gravel, petroleum, clays, natural gas.
Santa Barbara	[2] 103,173,649	113,543,610	Petroleum, diatomite, natural gas, natural gas liquids, sand and gravel, stone, lime, gem stones.
Santa Clara	26,702,305	28,785,089	Cement, stone, sand and gravel, clays, mercury, gem stones.
Santa Cruz	11,641,490	11,560,664	Cement, stone, sand and gravel, clays.
Shasta	6,166,232	6,017,746	Cement, sand and gravel, stone, volcanic cinder, clays, iron ore, barite, gold, silver.
Sierra	324,030	305,282	Sand and gravel, gold, stone, silver.
Siskiyou	535,713	861,414	Stone, pumice and volcanic cinder, sand and gravel, gold, gem stones, silver.
Solano	[2] 11,070,923	13,655,929	Natural gas, sand and gravel, stone, petroleum.
Sonoma	3,560,782	3,455,634	Sand and gravel, stone, mercury, natural gas, clays, gem stones.
Stanislaus	1,101,556	1,093,253	Sand and gravel, clays, gold, silver.
Sutter	6,071,675	11,853,047	Natural gas, sand and gravel, clays.
Tehama	2,695,206	899,718	Sand and gravel, natural gas, stone, pumice and volcanic cinder, gem stones, gold.
Trinity	281,045	246,800	Sand and gravel, stone, gold, silver.
Tulare	[2] 4,364,679	3,910,094	Sand and gravel, natural gas, stone, petroleum, barite, clays, gem stones.
Tuolumne	1,868,238	1,912,595	Stone, lime, uranium, volcanic cinder, sand and gravel, gold, clays, gem stones, silver.
Ventura	[2] 130,835,926	117,846,615	Petroleum, natural gas, natural gas liquids, sand and gravel, clays, stone, gypsum.
Yolo	[1]	3,539,425	Sand and gravel, lime, natural gas.
Yuba	3,997,167	3,606,858	Gold, sand and gravel, clays, platinum, stone, silver, copper.
Undistributed [3]	1,804,678	1,013,357	
Total	[2] 1,467,340,000	1,525,359,000	

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Revised figure.
[3] Includes gem stones, mercury, copper, gold, zinc, lead, and silver that cannot be assigned to specific counties and value indicated by footnote 1.

Alpine.—The Leviathan sulfur mine near Markleeville was idle throughout 1963. Near Hope Valley, sand and gravel was produced by Nevada Lumber Co. for use in building construction. State and county highway crews and contractors also produced these materials for use on roads near Picketts and Carson Pass.

Claude B. Lovestedt worked the Zaca mine in the Monitor area. Ore from the mine was milled and the concentrate shipped to the Selby smelter in Contra Costa County for recovery of silver, gold, copper, lead, and zinc.

Amador.—Glass, molding, and other industrial sands were produced by Owens-Illinois Glass Co. at Ione, by International Pipe & Ceramics Corp. (Interpace) at Ione and Howard and by Mines Engineering & Equipment Co. near Plymouth. Gravel used for fill was produced near Buena Vista by Harley H. Kreth. The demand for concrete aggregate was met by commercial producers in neighboring counties. Small quantities of sand and gravel were produced by road crews and contractors for projects in the Corral Flat area. Harbison-Walker Refractories Co. quarried quartzite near Ione for use in making silica brick until May 1 when the company's lease on the quarry terminated. Sierra Madre Stone Co. quarried dimension stone near Volcano for sale as flagging and in building construction. Interpace began operating its new $2 million clay-sand plant near the Owens-Illinois operation. The recovered clays and those mined by Harbison-Walker and Pacific Clay Products Co. in the same area were used in making heavy clay products and refractories. Calaveras Cement Co. mined fire clay near Buena Vista and sold it for refractory use. Industrial Minerals & Chemical Co. and R. J. Robideaux mined talc near Sutter Creek. Crude talc from both operations was ground by Industrial Minerals in its Sacramento County mill.

American Lignite Products Co. mined lignite near Ione and processed it in its Buena Vista plant to obtain montan wax and other products.

Itinerant prospectors panned stream gravels along the Cosumnes River and obtained small quantities of placer gold and silver.

Butte.—Production of natural gas from six dry-gas fields was virtually unchanged from that of 1962.

Nearly 3.5 million tons of sand and gravel as well as stone were produced for various construction uses, chiefly diversion tunnel lining, a fish hatchery, bridge piers, and the dam core block at the Oroville dam. Much of the sand and gravel output came from old dredge tailings along the Feather River; other sources were stream deposits on Butte and Dry Creeks and the Sacramento River. An extensive materials handling system was installed south of Oroville to transport materials to the Oroville dam project site. A large bucket-wheel excavator was planned for 1964 to replace the shovels and loaders.

Gold and silver were recovered from gold ore mined from the 3 Ravines claims near Butte Creek. Prospectors obtained small quantities of placer gold and silver from stream gravels in the Forbestown, Oroville, and Yankee Hill areas.

Calaveras.—Calaveras Cement Co. mined clays near Burson and San Andreas and limestone at two quarries near its San Andreas plant for use in portland cement. The cement was shipped to California and out-of-State customers. During 1963, the company removed a large tonnage of overburden from its limestone deposit southeast of the cement plant. Roofing granules were prepared by John C. Tarter at

the Candy Rock Quarry near Avery and by Ry-Lite Corp. of California at the Peirano Quarry near Altaville. Dimension building stone and colored aggregate for landscape use also were produced at the Candy Rock operation. Public works crews and contractors quarried nearly 95,000 tons of granite for road construction and maintenance. Sand and gravel and stone were produced for use in construction of the $35 million Camanche Dam. Appreciable tonnages were used at the site to construct one of the world's largest artificial salmon spawning beds. Sand and gravel was produced in other areas for various purposes by Neilsen's Gravel Plant, Inc., near San Andreas; A. A. Allen near Wallace; county maintenance crews; and contractors for the U.S. Army Corps of Engineers. Mission Clay Products Co. and Pacific Clay Products Co. mined fire clays from pits in the Valley Springs area and used the material to make heavy clay products. Jefferson Lake Asbestos Co. produced four grades of asbestos fiber at its mine and processing plant near Copperopolis. In September, the operation was reduced to a one-shift-a-day basis.

A few ounces of gold and silver were recovered from gold ores mined at the Carson Hill and Waterman properties at Carson Hill. Bench gravels near Robinson Ferry were worked by dragline excavator for gold and silver. Gold and silver were also recovered as a byproduct in the operation of a nonfloating sand and gravel washing plant on the Mokelumne River near Camanche and small quantities were obtained by individuals who panned stream gravels.

Colusa.—Production of dry natural gas rose nearly 15 percent above that of 1962 because of increased withdrawals largely from the Grimes field and to a lesser extent from the West Grimes and Sycamore fields. The other four producing gasfields in the county showed little or no change in output. Five gasfields were shut in during the year and major drilling was confined to the West Grimes field.

Building and paving aggregate was produced and prepared by Cortina Rock Products at Colusa, and by road crews and contractors from deposits along the Sacramento River.

Contra Costa.—Natural gas production rose 32 percent above that of 1962, but 57 percent of the total yield was gas from oil zones in the Brentwood field. Two new gasfield discoveries were made during the year—the Dutch Slough field by Signal Oil & Gas Co. and a new pool in the Concord field by Standard Oil Co. of California. The county was a newcomer to petroleum production and interest centered around further development of the Brentwood oil field. The 1963 production from this field was nearly 500,000 barrels.

Four petroleum refineries—Shell Oil Co. at Martinez, Standard at Richmond, Tidewater Oil Co. at Avon, and Union Oil Co. of California at Oleum—operated throughout 1963. The daily throughput capacities of the four plants were 55,000, 190,000, 135,000 and 48,000 barrels, respectively, unchanged from 1962.

Sulfur-recovery plants were operated at refinery sites by Standard, Union, and Tidewater. At the Selby lead smelter, stack gases were treated to produce liquid sulfur dioxide and sulfuric acid. At Pittsburg, Shell Chemical Corp. produced a thermal carbon black as a byproduct in the manufacture of ammonia fertilizers. Mountain Copper Co. reclaimed cement copper from solution residues in its Martinez chemical plant and shipped the metal to a smelter at Tacoma, Wash., for recovery of copper, gold, silver, and lead.

Sand and crushed stone were produced for the construction of subdivisions, shopping centers, roads, and a freeway tunnel, and for riprap in bank protection on the Sacramento and San Joaquin Rivers. About 290,000 tons of sand was produced at pits or dredged from bays to supply aggregate, fill, and industrial sands. Nearly 3 million tons of basalt, sandstone, and miscellaneous stone was quarried in the Clayton, Orinda, Pacheco, and Richmond areas. About midyear, the Blake Bros. San Pablo quarry near Point Molate was sold to Standard Oil Co. of California. Standard then leased it to Quarry Products, Inc. At Antioch, Fibreboard Paper Products Corp. used purchased limestone to make lime required in its sulfate paper-pulp operation. Kaiser Gypsum Co. calcined gypsum from Mexico in its Antioch plant and used it in making gypsum building products. Some of the crude gypsum was sold for cement retarder, mineral filler, and agricultural use. National Gypsum Co. was building a gypsum products plant at the Richmond inner harbor. The plant, expected to be on stream by August 1964, will be supplied with gypsum imported from Mexico. Miscellaneous clay for building brick manufacture was mined near Port Costa by Port Costa Brick Works and near Richmond by United Materials & Richmond Brick Co., Ltd.

Two operators dredged reed-sedge peat in the San Joaquin River delta and dried, shredded, and packaged most of the material for sale as a soil additive.

Del Norte.—Sand and gravel as well as stone were produced for building construction, roads, and public works projects including highway jobs near Klamath and the Oregon border and for the concrete lining of the new Randolph Collier tunnel. Virtually the entire sand and gravel output came from stream gravels along tributaries to the Smith and Klamath Rivers. Stone was quarried for riprap and road base by State and County crews and contractors.

El Dorado.—Stone production was only a little more than half the 1962 output. Less rubble and riprap was needed as various water and hydroelectric projects neared completion. Of the several producers of limestone, only Diamond Springs Lime Co. quarried the stone for making lime. The company used rotary kilns and a continuous hydrator to produce lime for construction, chemical, and other industrial uses. Sand and gravel was prepared for concrete aggregate in various county projects. Demand was high for sand and gravel for use in road structures and paving near Placerville and Pollock Pines; county road crews used it in highway jobs near Placerville, Camino, and Coloma. Pacific Mineral Products Co. sold its Shrub soapstone mine to Commercial Minerals Co., which mined soapstone and ground it in a San Francisco plant.

A few ounces of gold and silver were recovered from gold ore produced at the Minnehaha mine near El Dorado and from old tailings obtained at the Hazel Creek gold property. Placer gold and silver, recovered from the Hodgkin claims near Shingle Springs in 1955, were shipped to the U.S. Mint. Stream gravels of the Cosumnes River were panned by prospectors and yielded small quantities of placer gold.

Fresno.—Crude oil production dropped 10 percent and wet natural gas output decreased 5 percent compared with 1962. Despite the declines, Fresno County was sixth in oil production and tenth in marketed natural gas. The lower output was attributed to declines at the Coalinga East Extension, Raisin City, and Guijarral Hills fields.

Two wet natural gas processing plants extracted natural gasoline and cycle products and produced liquid-petroleum gas.

Total sand and gravel production declined from 4.5 million tons in 1962 to less than 3 million tons. The output for street, road, and highway paving dropped to less than half the 1962 figure. Commercial preparation plants working deposits near Fresno, Sanger, Coalinga, and Friant were the most seriously affected. Only those producers supplying or operating asphalt batch plants reported increased sand and gravel business. Most of the county's sand and gravel production came from stream beds and flood plains of the San Joaquin and Kings Rivers. Stone production, particularly for riprap and road base, was less than one-third that in 1962. Granite was quarried at Academy by Superior Academy Granite Co. for monumental and building stone. Some fusing-grade quartz was quarried near Huntington Lake by Pincushion Mining & Development Co. Valley Nitrogen Producers, Inc., obtained gypsum as a byproduct in the manufacture of phosphoric acid and sold the material for agricultural use.

Asbestos milling plants were operated near Coalinga by Atlas Minerals, Inc., and Coalinga Asbestos, Inc. The plant product in both instances was grade 7 shorts. Craycroft Brick Co. mined and used clays from a pit near Fresno in making heavy clay products. Fresno Perlite Corp. expanded crude perlite purchased from California and Nevada producers and sold the product for plaster aggregate, insulation, and as an ingredient in well drilling muds. Wilbur-Ellis Co. (formerly Fresno Agricultural Chemical Co.) custom-ground barite for use in drilling muds.

Three sand and gravel preparation plants on the San Joaquin River, near Friant, used sluice boxes to recover byproduct placer gold and silver. Cinnabar ore produced at the Mercy mine, Mercy Hot Springs area, was retorted during rehabilitation of an old haulage adit, and a small quantity of mercury was recovered.

Glenn.—Dry natural gas production was virtually unchanged from the 1962 level, and Glenn County was sixth among the State's 21 dry-gas producing counties. A high percentage of the output came from wells in the Beehive Bend field.

Sand and gravel was produced by commercial operators and by public works crews, chiefly from streambed deposits near Orland, Hamilton City, and the Colusa County line near Princeton. Demand for use in structures, buildings, and paving exceeded that in 1962. The Wyo pit of Southern Pacific Co. yielded nearly 110,000 tons of gravel that was stockpiled for railroad ballast use. A small tonnage of stone was quarried by county crews for use in road maintenance. Holly Sugar Co. purchased limestone and used a shaft-type kiln and continuous hydrator to produce carbon dioxide and lime used in sugar refining.

Humboldt.—Dry natural gas, from two fields, rose 44 percent above that in 1962, but the total for the year was less than 2 billion cubic feet.

Pit-run and prepared sand and gravel were produced along the Klamath, Mad, Van Dusen, and Eel Rivers. The 1.6 million-ton total was supplied about equally by commercial plants and public works crews and contractors. Nearly 75 percent of the total output was consumed in State highway projects, chiefly on U.S. Highway 101. The tonnage of sand and gravel prepared for residential and commercial building

construction was appreciably below that in 1962. Virtually all the nearly 310,000 tons of stone quarried during 1963 was used as base course and riprap in roads, levees, and harbor facilities.

Bench gravels on the Orcutt claims near Orleans were worked to recover placer gold.

Imperial.—Gypsum was mined in the Fish Creek Mountains by U.S. Gypsum Co. and calcined in the company plant at Plaster City for use in making gypsum products. Over 900,000 tons of sand and gravel was produced and prepared by operators of stationary and portable plants in the El Centro, Salton City, Brawley, Westmoreland, Seely, and Holtville areas. The tonnages prepared for building construction and for the manufacture of drain tile were higher, but the quantity produced for paving was below that of 1962. Stone was quarried for riprap by crews and contractors for the Bureau of Reclamation and the Imperial Irrigation District and used in projects along the Colorado River.

Holly Sugar Co. purchased limestone and operated shaft-type kilns at Carlton to produce carbon dioxide and lime used in sugar refining. Western Non-Metallics mined and ground mica (sericite schist) near Ogilby and sold the product to manufacturers of roofing materials. California Mining Co. mined bentonite near Brawley for use as a filler in livestock feeds. Organic Mineral Sales, Ltd., mined and stockpiled crude barite at the White Swan property near Blythe. Aricalite Builders Supply Co. mined pumice near Calipatria and prepared the material for use as lightweight concrete aggregate.

Gold ore mined at the Calcite and Big Chief claims near Mesquite was shipped to the Selby smelter, Contra Costa County, for recovery of gold and silver. The Rainbow group of claims (unsurveyed area) yielded gold ore that was treated to recover gold and silver.

Inyo.—Union Carbide Nuclear Co. operated the Pine Creek tungsten mine, mill, and chemical plant throughout 1963. This was California's only active tungsten operation and yielded all the State's tungsten and molybdenum concentrates, a high percentage of the recoverable copper, and much of the recoverable lode silver. Union Carbide used company-produced and purchased tungsten concentrates to make ammonium paratungstate in its chemical plant. Lead-zinc ore from the Santa Rosa mine southeast of Keeler and lead ores from the Defense mine east of Darwin and the Jubilee mine west of Shoshone yielded a high percentage of the State's recoverable lead and zinc. A little lead ore containing recoverable lead, silver, and gold was produced from the Bunker Hill property in the Kearsarge area. Gold ore from the Cecil R. claims in the South Park area, and bullion produced at the Silver Bell and Del Norte groups of gold claims in the Wild Rose area were treated at the Selby smelter where gold and silver were recovered. Nearly 900 tons of direct shipping grade iron ore, produced as the result of exploratory work at the deposit, was shipped from the Iron Cap mine, in the Argus Range southwest of Ballarat.

Pittsburgh Plate Glass Co. recovered soda ash and sodium sesquicarbonate from brines of Owens Lake in its Bartlett plant. U.S. Borax & Chemical Corp. mined colemanite in Corkscrew Canyon (DeBely mine) and ulexite near Shoshone (Gerstley mine) and shipped the minerals to its Kern County boron refinery. Kern

County Land Co. mined and shipped colemanite from its Kern Borate mine west of Death Valley Junction.

Production and shipments were reported from 10 talc mines; however, output from the Warm Springs mine of Grantham Mines was more than that from the other 9 mines combined. Talc from the Warm Springs mine was shipped to grinders in Los Angeles and Victorville and exported to Mexico. Talc grinding plants were operated at Laws by Huntley Industrial Minerals Co. and at Keeler by Sierra Talc Co. In November, Standard Slag Co. announced the acquisition of operating control of the Huntley plant and properties.

Sand and gravel production fell far below the 1962 output, primarily because of completion of highway projects in the Bishop and Death Valley areas. Stone output rose 7 percent because of the increase in granite quarried for use in maintenance of the Los Angeles water system in the Owens Valley. A larger tonnage of quartzite, all from the Lone Pine area, was quarried for making silica brick than in 1962. Quartzite from a quarry near Deep Springs was used chiefly for exposed aggregate in concrete structures. Limestone was quarried by Stauffer Chemical Co. near Searles Lake for use in making lime. Some dimension building stone was produced from the Stutterite limestone quarry in the same area. Premier Marble Products quarried marble near Lone Pine for building stone and roofing granules. Fuller's earth was mined from the Calearth deposit near Olancha by Sierra Talc Co., and bentonite was mined from the Ibex pit near Tecopa by C. K. Williams Co. and from the Side Hill property in Death Valley by L. R. Moretti. The fuller's earth was prepared for use as a carrier in insecticides and fungicides; the bentonites were processed for the pharmaceutical and cosmetic industries.

Near Little Lake, pumice was mined from the Crownite deposit, and volcanic cinder was mined from the Redlite property. Except for a small tonnage of pumice sold for soil conditioning, the materials were prepared for lightweight aggregate. American Perlite Co. mined crude perlite from its Fish Springs quarry near Big Pine and sold it to expanding plants outside the county. Inyo Soil Sulphur Co. mined sulfur at its Crater deposit and prepared it for agricultural use.

Kern.—Kern County yielded more than 95 million barrels of crude oil and 117 billion cubic feet of natural gas and was by far the State's leader among oil and gas producing counties. Oil production increased 5 percent and natural gas 2 percent above 1962 figures. Heavy crude oils were of special interest and many new projects were underway to increase their production. Most projects used heat to reduce the viscosity and gravity of the crude oil for easier pumping. The injection of diluents was tested to a limited extent. At least seven oil discoveries were reported in 1963, including one new field. Standard Oil Co. of California discovered the English Colony field and had three new pool discoveries in the Midway-Sunset field, two of which were low-gravity oil.

Seventeen plants processed wet natural gas to produce natural gas liquids. Production of natural gasoline and cycle products declined 3 percent and that of LP gas 7 percent compared with 1962. Carbon dioxide was extracted from natural gas by Tidewater Oil Co. in its plant near Taft. Production was well above that in 1962. Eight operating refineries had a combined throughput capacity of 91,100 barrels daily, 16 percent greater than a year earlier. Continental

Carbon Co. and United Carbon Co. produced carbon black in plants at Bakersfield and at Mojave, respectively.

U.S. Borax & Chemical Corp., the Nation's leading producer of boron minerals and compounds, mined crude borates from its open pit at Boron and refined or partially refined the minerals in an adjacent plant. Boron minerals from company mines in Inyo County also were refined in the Boron plant. Sodium sulfate was produced as a byproduct of borate refining. Some partly refined borates were shipped to the company refinery in Los Angeles County for further processing. Crude and partly refined borates were sold to chemical plants outside the county and to the Federal and State Forest Services for use as a fire retardant in fighting forest fires.

Portland cement was produced in the California Portland Cement Co. dry-process plant at Mojave and in the Monolith Cement Co. wet-process plant at Monolith. Nearly 70 percent of the output from the two plants was shipped to ready-mixed concrete plants in California, Nevada, and Arizona. Sand and gravel production by commercial plants was virtually unchanged from that of 1962. However, the tonnage produced by State and county crews and contractors was less because of a lower demand for paving. Stone production also was lower because requirements for riprap and road base material were below 1962 levels. Much of the 1963 stone output was limestone quarried for use by the California Portland and the Monolith cement plants. Roofing granules were prepared at the Star dolomite quarry near Maricopa and the Mojave Rock Products quarry near Mojave. Quartz was quarried on the Sweetser property near Rosamond and used for exposed aggregate in concrete walls. Desert Rock Milling Co. obtained stone for landscaping, roofing granules, and building stone at several quarries in the Rosamond area. More than 900,000 tons of gypsum was mined near Lost Hills, Taft, and Maricopa, principally for agricultural use. Some crude gypsum from the Bitterwater mine of Superior Gypsum Co. was sold as a cement retarder.

Western Salt Co. harvested crude solar-evaporated salt from Koehn dry lake and processed it in its Saltdale plant. The plant product was shipped to customers in Los Angeles County. Clays were mined near Tehachapi for use in making cement at Monolith. Clays used as an ingredient in compounding drilling muds were dug from pits near Rosamond, McKittrick, and Mojave. The McKittrick and Mojave locations also provided clays used as absorbents and for making pottery and stoneware. At Rosamond, Macco Corp. ground barite from its Tulare County mine for use in well drilling muds, glass, and paint. Pumice mined at the Calsilco claims north of Saltdale was sold for scouring, abrasive, absorbent, and filler uses.

Tehachapi Mercury, Inc. (formerly Sierra Quicksilver Corp.) furnaced ore from its mine near Keene and recovered over 30 flasks of mercury. Tin concentrate was produced from ore mined at the Meeke-Hogan property near Gorman and shipped to an out-of-State customer. Bullion produced from gold ores of the Butte, G. B., Yellow Aster, and Butte Lode mines (old tailings) in the Randsburg area was shipped to the Selby smelter for recovery of gold and silver. When the Griffith Co. sand and gravel plant near Bakersfield was dismantled, cleanup operations yielded a few ounces of placer gold. Prospectors panned stream gravels at various locations and recovered small quantities of placer gold and silver.

Kings.—Production of wet and dry natural gas rose 75 and 25 percent, respectively, compared with 1962 figures. The wet gas increase was attributed to reduced injection rates in the Kettleman North Dome field. Crude oil output dropped 11 percent as a result of normal field declines. The county had one operating oil refinery, near Hanford, and five wet natural gas processing plants.

All sand and gravel and stone produced was used for base material in roads by contractors for the State Highway Department, Lemoore Naval Air Station, and the county road agency. Sand and gravel as well as crushed stone used as concrete aggregate were supplied by producers in Fresno and Tulare Counties. McPhaill Gypsum Co. mined agricultural gypsum near Avenal until dissolution of the company late in the year.

Ores from the Dawson and Little King mercury mines in the Parkfield area were retorted and several flasks of mercury were recovered.

Lake.—Sand and gravel was produced for building construction and for repair and maintenance of roads. Stationary and portable preparation plants in the Clearlake-Highlands-Lakeport area supplied over 350,000 tons of pitrun and processed sand and gravel. No stone production was reported. Volcanic cinder was mined near Clearlake Oaks by Cinder Products Co. and sold for landscaping and roofing granule use. Near Clearlake Highlands, Roger Hellgren mined volcanic ash for use as fill. American Mineral Resources Development Co. mined sulfur ore on the S Bar S Ranch east of Kelseyville and sold the material for soil conditioner. Thomas Gion mined shale from the Konocti deposit near Kelseyville and sold it for use in surfacing roads.

Mercury ore from the Abbott mine in the Sulfur Creek area was retorted, and several flasks of the metal were recovered. At the Baker mine in the Clearlake area, mercury ore was upgraded by gravity concentration before furnacing.

Lassen.—All the Lassen County production of sand and gravel and stone was by State and county road crews and by the Sierra Ordnance Dept. More than 200,000 tons of sand and gravel and 14,000 tons of stone were used as road base and concrete aggregate. State highway crews mined volcanic cinder for use in the repair and maintenance of roads, and Mt. Lassen Cinder Co. worked the Poison Lake cinder deposit for material used as concrete aggregate.

Prospectors panned streambed gravels and recovered small quantities of placer gold.

Los Angeles.—Crude oil production rose 5 percent above that in 1962 and the natural gas yield was up 4 percent. All but 3 percent of the natural gas came from oil zones. The increases were largely the result of secondary recovery projects. The Wilmington field had a reported oil production increase of nearly 3 million barrels; the Las Cienegas field had an increase of 1.2 million barrels; and the Cheviot Hills and Yorba Linda fields had increases of 500,000 barrels each. In the Las Cienegas field, Union Oil Co. of California made a new pool discovery. Los Angeles County was the State's petroleum refining center, with 16 operating refineries with a combined throughput capacity of 789,140 barrels daily. This was 58 percent of California's refining capacity. During 1963, 7,500 barrels daily of refining capacity was added and 9,960 barrels daily was either retired or shut down temporarily. Nineteen natural gas liquids plants extracted more than 260 million gallons of products, 3 percent less than in 1962.

Sulfur recovery plants (removing elemental sulfur from effluent gases at petroleum refineries and other industrial plants) were operated by Wilshire Oil Co. near Santa Fe Springs, by Stauffer Chemical Co. near Long Beach, and by Collier Carbon & Chemical Corp. near Wilmington.

Nearly 27 million tons of sand and gravel was produced by commercial producers, Government crews, and on-site contractors. The increase over 1962 was 3 percent for use in buildings and structures and 5 percent for use in paving. Over 1 million tons was used as fill and other construction uses, a 19-percent increase. Twelve commercial plants each produced more than 1 million tons of sand and gravel, totaling about 21 million tons. Seven of 14 other commercial plants each produced between 500,000 and 1 million tons. Construction, repair, and maintenance of roads and structures administered by the State required over 5 million tons of sand and gravel. This was supplied by commercial operators and State crews. The output of industrial sands was higher than in 1962 for molding and foundry uses and less for blast and engine uses. Stone production dropped about 700,000 tons compared with 1962, primarily because of lower demand for dike and revetment rock from quarries on Santa Catalina Island and some mainland quarries. More base course material was quarried at granite operations than in 1962 and the demand for dimension building stone was higher.

Fibreboard Paper Products Corp. operated its South Gate lath, plaster, and wallboard plant on gypsum received from a company mine in Nevada. Kaiser Gypsum Co. imported gypsum from Mexico for its Long Beach plant. Clays used in making heavy clay products were mined from pits near Compton, Castaic, Los Angeles, Torrance, Reseda, and Van Nuys. A comparatively small tonnage of shale was mined in the San Fernando area and sold for use as a carrier in insecticides and fungicides. A few tons of soapstone was mined in Sierra Pelona Valley and shipped to a Los Angeles grinder. Six plants ground talc, soapstone, and pyrophyllite from mines in California and Nevada. Nine plants in the Los Angeles area expanded crude perlite obtained from producers in California, Nevada, Arizona, and New Mexico. A Harbor City plant ground barite mined in Nevada and prepared it for use in well drilling muds. California Zonolite Co. exfoliated vermiculite from its Montana mine and sold the product for lightweight aggregate, insulation, and soil conditioner. The Los Nietos plant of Sunshine Mica Co. dry-ground scrap mica purchased from Colorado and South Dakota producers and imported from India. The plant product was sold to manufacturers of roofing materials.

U.S. Borax & Chemical Corp. operated its Wilmington refinery on crude and partly refined borates received from company operations in Kern County. Some sodium sulfate was produced as a byproduct in borate refining. Waste oil-well brines of the Los Angeles Basin were pumped to The Dow Chemical Co.'s iodine recovery plant in Orange County.

A few ounces of gold and silver were recovered from gold ore mined from the Red Rover claims, near Acton, and shipped to the Selby smelter. San Gabriel Valley Placers operated sluice boxes in conjunction with the Azusa Gravel preparation plant and recovered placer gold and silver. Individuals panned stream gravels in the San Gabriel River channel and recovered small quantities of placer gold.

Madera.—Production of dry natural gas was limited to the Chow-

chilla, Moffat, and Gill Ranch fields, where the combined yield was only slightly more than 2 billion cubic feet. The Gill Ranch field produced 96 percent of the total and was the only field with development drilling in 1963.

Sand and gravel production rose more than 100,000 tons from 1962, principally for building and paving use. Commercial preparation plants operated near Madera, Chowchilla, and Pinedale. Government contractors produced the materials for use in State and county highway projects. Dimension granite was quarried near Raymond by Raymond Granite Co. and was sold for architectural and monumental uses. Building stone and rubble was quarried by Sierra Lava Stone Co. near Madera. A small tonnage of granite was produced by road maintenance crews of the county and the U.S. Forest Service. California Industrial Minerals Co. obtained volcanic ash from the Taylor cinder deposit near Belleview and prepared the material for use as a carrier in pesticides. U.S. Pozzolan Corp. mined pumice for lightweight aggregate from its Erickson property in the same area. Hans Sumpf Co. mined clay near Madera and used the material in the manufacture of adobe brick.

A few tons of gold ore, mined from the Lucky Bill claim near Potters Ridge, contained recoverable gold. A suction dredge worked stream gravels on the North Fork of the San Joaquin River and recovered placer gold and silver. Byproduct placer gold and silver were recovered at two sand and gravel (nonfloating) preparation plants on the San Joaquin River near Friant. Small quantities of the metals were recovered by individuals who panned stream gravels at various locations. The Strawberry tungsten mine and mill of New Idria Mining & Chemical Co., near Bass Lake, was idle throughout the year.

Marin.—Quarries near Novato (basalt) and Greenbrae (sandstone) supplied large tonnages of stone, most of which was shipped by barge outside the county for use as riprap, roadbase, and concrete aggregate. Miscellaneous stone was quarried by maintenance crews at Fort Bragg for use as fill and embankment protection. Although sand was dredged from the San Francisco Bay and sand and gravel was produced from various stream bed deposits, virtually all the sand and gravel required to meet increased building activity was trucked in from Sonoma County. L. P. McNear Brick Co. and The McNear Co. quarried shale at San Pedro Hill near San Rafael and used the material in making brick and lightweight aggregate. At Sausalito, Scottlite Products expanded perlite received from a Colorado producer.

Ore mined at the Gambonini (Buena Serte) property was retorted and about 68 flasks of mercury recovered. A few flasks of the metal also was recovered by retorting ore mined at the Chileno Valley mine near Marshall.

Mariposa.—Over 40,000 tons of sand and gravel was produced in preparation plants in the Groveland, Mariposa, and El Portal areas and by State, county, and National Park Service maintenance crews. A small tonnage of decomposed granite was quarried on U.S. Forest Service land for road and embankment repair. Dimension building stone was produced at the Haighs and Mary Harrison quarries near Coulterville. Slate was mined at the Mt. Bullion quarry near Bear Valley for roofing and flagging.

Three lode gold mines were active during part of 1963. The Red Banks mine near Kittridge yielded most of the gold and silver re-

covered. Cleanup operations at the Nelly Kaho property near Mt. Ophir yielded a few ounces of gold. Suction dredges on the Merced River, at McCabe Flat, and near Kittridge worked stream gravels for placer gold and silver. Mariposa Sand & Gravel Co. recovered byproduct placer gold and silver at its nonfloat washing plant near Morman Bar. Stream gravels near Coulterville were panned by prospectors for gold and silver.

Mendocino.—Sand and gravel production totaled over 1 million tons, more than double the 1962 output. State highway projects on U.S. Highway 101 in the Willits, Ukiah, and Laytonville areas required over 700,000 tons of the materials. The remaining tonnage was used in other public works projects, chiefly for building and paving. Nearly 70,000 tons of stone was quarried by government crews and contractors for use as riprap and roadbase.

High-grade mercury ore was mined and retorted at the Janusz "B" prospect near Hopland and three flasks of the metal were recovered.

Merced.—Over 1.5 million tons of sand and gravel was produced at commercial operations in the Merced, Atwater, Ballico, Snelling, LeGrand, and Los Banos areas and by public works crews and contractors. More than half the total output was used in the construction of State and County roads and for access roads to the proposed San Luis dam, a unit of the Central Valley water project. Gypsum was mined by Agricultural Minerals & Fertilizer at the Ortigalita deposit near Los Banos.

Sluicing methods were used by River Rock, Inc., at its sand and gravel washing plant on the Merced River near Snelling to recover byproduct placer gold and silver.

Baroid Division, National Lead Co., processed barite from its Nevada mine in the company's Merced plant. The plant product was used in compounding well drilling muds.

Modoc.—About 365,000 tons of sand and gravel was produced by construction and maintenance crews for State, county, and city (Alturas) road agencies. Aggregate requirements for concrete structures and bituminous paving in the Alturas area was supplied by Moyer Gravel Co. which obtained the material from an alluvial terrace on the north fork of the Pit River. A small tonnage of dimension stone was quarried on U.S. Forest Service land for use as rubble. A contractor for the State obtained volcanic cinder at various locations and used the material in road maintenance and repair.

American-Modoc, Inc., mined peat moss from a bog in Jess Valley near Likely until May 10th, at which time the operation was purchased by John G. Harris. Harris continued the operation throughout the remainder of the year. All production was dried, shredded, and packaged for sale as a soil improvement agent.

Mono.—U.S. Pumice Supply Co., Inc., mined pumice near Lee Vining and prepared the material for use as abrasive. Featherock, Inc., obtained pumice in the same area and sold it for landscaping and decorative use. Near Benton, Bishop Building Materials mined pumice from the Cowan property for use as lightweight aggregate. Andrew Boyd mined pumice north of Bishop and prepared the material for concrete and plaster aggregate. He sold a small tonnage for roof insulation.

Sand and gravel as well as stone were produced by maintenance crews and contractors for the State highway agency. The materials were used to complete the last phase of road projects in the Mammoth

Lakes and June Lake areas and the initial phase of highway construction in the Lee Vining area.

Huntley Industrial Minerals Co. mined kaolin from the Little Antelope deposit in the Casa Diablo area and pyrophyllite at the Pacific property near White Mountain. The kaolin was sold for use in cement and for various filter applications. The pyrophyllite was ground in the company plant at Laws, Inyo County, for use in pesticides and paint. Late in the year, Standard Slag Co. acquired controlling interest in all the Huntley holdings.

Monterey.—Production of crude oil and wet natural gas declined 9 and 18 percent, respectively, compared with 1962 figures. The lower outputs were attributed to the normal declines of older fields. A new oil field discovery (Quinado Canyon) was made by Baron Kidd. The initial well pumped 6 barrels a day of heavy oil.

The combined output of sand and gravel and industrial sands rose nearly 130,000 tons above that of 1962. Large tonnages of sand and gravel were produced by county road crews and by contractors for the State highway agency, primarily for road construction in the San Ardo, Salinas, and Monterey areas. Twelve commercial stationary preparation plants were operated in the sand dunes facing Monterey Bay between Pacific Grove and Castroville and at streambed deposits on the Carmel and Salinas Rivers. Industrial sands were prepared for the most part at plants working the dune deposits. Glass sands were produced by Owens-Illinois Glass Co. and Del Monte Properties Co. near Pacific Grove. The latter processed sand for various industrial uses and produced silica and feldspar concentrates. Del Monte blended and/or ground the materials to customer specifications.

Kaiser Aluminum & Chemical Corp. quarried dolomite at Natividad and upgraded it by heavy-medium separation. Some of the dolomite was sold for roofing granules, landscaping rock, industrial fillers, and various other uses. The remainder was either calcined and hydrated to produce dolomitic hydrated lime, primarily for use as a precipitant at Kaiser's Moss Landing magnesia plant, or was dead-burned for use as metallurgical flux and for making refractory brick. Some of the lime was sold for construction and agricultural use. Some magnesium hydroxide recovered in the company's sea-water-processing plant was sold, but most of the product was consumed by Kaiser in making refractories.

Near Salinas, Spreckles Sugar Co. burned purchased limestone to obtain carbon dioxide and lime used in processing sugar beets. Granite quarried near Monterey and Salinas was used as base material and fill. Monterey Bay Salt Co., Inc., harvested crude salt from several hundred acres of solar evaporating ponds near Moss Landing and sold the product locally to ice companies, water softening companies, food processors, and others.

Howard Hilton shipped about 1 ton of gold ore containing recoverable gold and silver from the Lucky Mo claim near Alder Peak to the Selby smelter.

Napa.—Basalt Rock Co. mined shale near Oakville and expanded the material for lightweight aggregate in its Napa plant. Basalt also prepared a pozzolan for cement from diatomaceous silica mined by the company near Napa and quarried rhyolite at the nearby Pedrotti quarry for riprap, base material, and concrete aggregate. Sand and gravel was produced by commercial operators and county crews for structural and paving uses.

Leslie Salt Co. harvested crude salt from solar evaporating ponds along San Pablo Bay. Asbestos Bonding Co. produced several grades of asbestos filler material at its Phoenix mine and plant near Napa. Perlite Rock Co. expanded perlite from the Alvo mine, near St. Helena, in a nearby plant.

Five operators recovered mercury by retorting dump material from the Oat Hill mine or worked the James Creek gravels to recover mercury washed down into the creek bottom from the old Oat Hill operation. Ore from the Knoxville mine, near Knoxville, yielded mercury by retorting.

Nevada.—Clements Rock Products, Inc., at Truckee and Hanson Bros. Enterprises, Inc., at Grass Valley produced most of the sand and gravel in stationary preparation plants. The remainder was produced by State and county road crews and on-site contractors. Much of the total output was used in the Soda Springs section of Interstate Route 80.

Most of the lode gold and silver output came from treatment of dump material and old tailings at the Empire Star Group in Grass Valley as well as cleanup operations at the Brunswick-Idaho-Maryland workings in Grass Valley and the Red Ledge mine near Washington. Gold was recovered from ore specimens at the Queen property near Washington. About 10 tons of gold ore was shipped from the Indiana mine south of Grass Valley to the Selby smelter. Fourteen placer properties were active part of 1963. Except for production from a drift mine in the Bear Valley area and from two nonfloat washing plants in the French Corral area, placer gold and silver was recovered principally by individuals who panned stream gravels in the Grass Valley-Nevada City, Washington-North Columbia, French Corral and Bear Valley areas. A few of these itinerant miners used sluicing methods to wash the stream and ancient riverbed gravels.

Orange.—Nearly 32 million barrels of crude oil were produced, 3 percent more than in 1962. Much of the increase was from the Yorba-Linda field where 12 new wells were drilled. Most other fields recorded slight production declines. Exploratory drilling resulted in one extension (pool and field), and one test went to basement. Natural gas output totaled more than 32 billion cubic feet, also an increase of 3 percent compared with 1962. All gas production was from oil zones. A major part of the increase was credited to the Huntington Beach field where 75 new wells were drilled. Six plants processed wet gas to recover natural gas liquids and plant recovery was 4 percent above a year earlier. There was one oil refinery in the county, the 5,000 barrel-a-day Huntington Beach refinery of Socal Oil & Refining Co.

Over 9 million tons of sand and gravel was produced at commercial stationary and portable plants and by construction contractors. Larger tonnages of building and paving sand and gravel were required for suburban development and primary and secondary road construction. Several sand and gravel producers ceased operations either because of depletion of pits or because of home-owner pressure to abandon the ground. Several small estates were rezoned by the county government to permit sand and gravel operations. Industrial sands were mined in the Trabuco Canyon and El Toro areas and prepared for cement, ceramic, and refractory uses. The R. W. McClellan & Sons granite deposit yielded some stone used as base material, but operations were discontinued before yearend. The company also

operated a peat humus pit near Huntington Beach. Some of the peat was sold unprepared in bulk, but much of the output was mixed with earth for sale as top soil. A comparatively small tonnage of stone was quarried in the Cleveland National Forest for embankment use.

Clay-sand mixtures were mined in the Trabuco Canyon area by California Nonmetallics and near El Toro by W. A. Schoeppe Clay Co. Some material from each property was marketed for foundry ganister and both companies prepared washed kaolin and sand for sale. Clays were dug near Huntington Beach by La Bolsa Tile Co. and near Corona by Pacific Clay Products Co. and used in making heavy clay products. Riverside Cement Co. mined clays near San Juan Capistrano for use in making cement. Shale was mined and expanded for lightweight aggregate near San Clemente by Crestlite Aggregates Co. At Dyer, Holly Sugar Co. purchased and burned limestone to produce carbon dioxide and lime used in processing sugar beets. Western Salt Co. harvested crude salt from the solar evaporating ponds of Newport Bay Salt Works at Corona Del Mar. The product was sold locally. Some salt works bittern was sold for use as a herbicide. The Dow Chemical Co. extracted iodine from waste oil-well brines of the Los Angeles Basin in a Seal Beach plant. The company announced it was re-evaluating its 1962 decision to consolidate all iodine production in Michigan by late 1964.

Placer.—Sand and gravel production was only half that of 1962, primarily because of a lower demand for paving aggregate. However, gains were reported in output for building construction. The principal commercial producers operated preparation plants in the Auburn, Colfax, Lake Combe, and Lake Tahoe areas. At the Lake Combe operation, specialized industrial sands also were produced. Granite was quarried near Rocklin by Union Granite Co. for monumental and building stone uses and the fines were sold for poultry grit. Gene Scott mined decomposed granite near Auburn and sold the material for landscaping use and fill. A relatively small tonnage of stone was quarried on National Forest land and was used in road maintenance. International Pipe & Ceramics Corp. and Lincoln Clay Products Co., Inc., mined fire clays in the Lincoln area for manufacturing brick, structural tile, and sewer pipe.

A few ounces of lode gold and silver were recovered from ore mined at the Rawhide property near Dutch Flat. One drift mine, a suction dredge, a dragline excavator, and several sluicing operations were active, yet most of the placer gold and silver was recovered by individuals who panned stream gravels at widely scattered locations.

Plumas.—The tonnage of sand and gravel produced at commercial plants in the Quincy and Portola areas and by public works contractors was nearly double the 1962 output. Appreciable quantities of sand and gravel also were produced by State and county maintenance crews. The State crews used much of their output to repair roads and bridges near Quincy after the February floods. The tonnage produced for road construction increased 100 percent and was used chiefly in a State highway project near Canyondam. Stone was quarried on the Tobin property of Western Pacific Railroad Co. for riprap and on National Forest land for rubble.

Metal mining was limited to the search for placer gold. In the La Porte area, a drift mine and a suction dredge were active and old tailings were reworked to recover placer gold and silver. Placer gold was recovered from material produced at a drift mine near Green-

ville in 1961 and 1962. Individuals panned stream gravels in the Butte Valley and La Porte areas for placer gold and silver.

Riverside.—Iron ore production and shipments from the Eagle Mountain property of Kaiser Steel Corp. increased more than 50 percent from the 1962 figures. The increase resulted not only from demand made by Kaiser furnaces at Fontana, which operated at near capacity most of the year, but also from commitments in new export contracts with Japanese steel interests. A few tons of iron ore was mined from the Storm-Jade underground workings, north of Chiriaco Summit in the Joshua Tree National Monument, but no shipments were made.

Regular and white portland cements were produced in the Crestmore plant of Riverside Cement Co. During the year the company added three grinding mills, blending equipment, and silos to the regular cement plant, completing the second phase of a multimillion-dollar rebuilding program. When completely rebuilt, the plant will have an annual capacity of 4.5 million barrels. Engineering plans were underway at yearend to double the capacity of Riverside's white cement plant.

The tonnages of pit-run and prepared sand and gravel produced totaled nearly 600,000 tons more than in 1962. Paving projects consumed over 1.5 million tons. Demand for sand and gravel for building rose to about 600,000 tons. Over 400,000 tons was used for fill and other construction needs, in cement manufacture, and specialized industrial uses such as glass. The Corona area supplied much of the sand for cement. Lower demand for base materials adversely affected production at decomposed granite deposits and the total output of stone. Granite was quarried near Riverside and Corona for riprap, road base, fill, and poultry grit. Limestone was quarried at Crestmore for making cement and at Riverside and Nightingale for roofing granules and decorative use. Dimension and crushed quartzite were quarried at the Painted Hills deposit, north of Whitewater, for rubble and landscaping use. Minnesota Mining & Manufacturing Co. prepared artificially colored roofing granules from stone quarried in Temescal Canyon and supplied crushed or ground stone for use as riprap, road base, filler, and sand blasting.

Six producers mined clays in the Alberhill, Corona, and Elsinore areas for the manufacture of heavy clay products. Clays mined in the El Cerrito and Crestmore areas were used in making cement. U.S. Gypsum Co. mined and calcined gypsum at Midland for use in making plaster and wallboard. Some crude gypsum was sold for agricultural use. Float wollastonite was collected in the Midland area and sold for decorative use.

Morongo Corp. dug reed-sedge peat near Banning. The material was air-dried and shredded for bulk shipment to customers, who sold the product as a soil improvement agent or used it as an ingredient in mixed fertilizers. All crude oil production was from the Prado Dam field. The yield, less than 3,000 barrels, was virtually unchanged from that in 1962. Several hundred tons of uranium ore was mined by Humbug Development Co. at its Northeast group of claims northeast of Blythe and shipped to a processing plant in Utah.

Sacramento.—Sacramento led all other counties in dry natural gas production with nearly one-fifth the State's total yield and a rise in output of 3 percent above 1962 figures. Production increases were reported for the Freeport, West Thornton-Walnut Grove, and River

Island fields. The Rio Vista field, half of which lies within the county, recorded a negligible decline.

Sand and gravel production increased about 1 million tons compared with 1962, when the construction industry underwent a 2-month-long strike. Demand was high for paving and fill for subdivisions, roads, and Government installations, especially at McClellan Air Force Base. Of the nearly 5 million tons of sand and gravel produced, chiefly at commercial plants in the Sacramento and Fair Oaks areas, 91 percent was prepared (washed and screened) and the remainder was pit-run. Except for about 4 percent that was moved by rail, transportation was by truck. A comparatively small tonnage of stone was quarried by a contractor for use in a Government project. Miscellaneous clay was mined by the Cannon Co. at Michigan Bar and by the Sacramento Brick Co. near Sacramento for use in making heavy clay products. In the Ione area, Industrial Minerals and Chemical Co. and R. J. Robideaux mined fire clays for use in making stoneware products, fire brick and block, and fire-clay mortar; for use in the manufacture of rubber; and for use as a carrier in insecticides and fungicides. At Florin, Industrial Minerals ground barite from Nevada for its own use and custom-ground other nonmetallic minerals to customer specifications. California Zonolite Co. exfoliated crude vermiculite from its Montana mine for sale as insulation, aggregate, and soil additive.

Metal production was virtually limited to byproduct placer gold and silver recovered at four nonfloating sand and gravel preparation plants along the American River near Folsom. Only 1 ounce of placer gold was reported recovered by individuals who panned stream gravels in the same area.

San Benito.—Six mercury properties were active all or part of the year but only one, the New Idria, yielded more than a few flasks of the metal. The New Idria mine was the Nation's largest mercury producer. County production was 1 percent above that of 1962. Relatively small quantities of crude oil and natural gas (wet and dry) were produced, and declines of 17 and 35 percent, respectively, were reported as compared with 1962.

Ideal Cement Co. produced portland cement in a wet-process plant at San Juan Bautista. Raw materials were obtained from a nearby limestone quarry and a shale pit in Santa Cruz County. The company shipped cement to California and out-of-State customers. Limestone quarried near Hollister was shipped to an Alameda County magnesia plant. Wilbur-Ellis Co. obtained bentonite from the Lewis pit near Idria and prepared it for use as a water seal in reservoirs, carrier in pesticides, ingredient in foundry facings, component in drilling muds, and various other uses.

Sand and gravel production was higher than in 1962. Principal producers were commercial plants in the Hollister area, county road crews, and contractors for Pinnacles National Monument. The demand was chiefly for paving sand and gravel; requirements for building construction were appreciably below those of 1962. Granite was quarried at the Logan quarry for riprap, road base, and concrete aggregate. Asbestos ore from the Union Carbide Nuclear Co. holdings in the southeast corner of the county was hauled to the company plant in Monterey County for fiber recovery.

San Bernardino.—Four cement plants, with a combined yearend capacity of over 22 million barrels, produced nearly 17 million barrels

of portland cement and made shipments totaling more than 16 million barrels to customers in and out of the State. Dry-process plants were operated by California Portland Cement Co. at Colton and by Riverside Cement Co. at Oro Grande. Southwestern Portland Cement Co. at Victorville and Permanente Cement Co. at Cushenbury used the wet process. Cement plant expansions completed in 1963 added nearly 3 million barrels to the cement-producing capacity.

Searles Lake brines yielded sodium borates, boric acid, potassium chloride and sulfate, sodium carbonate and sulfate, dilithium-sodium phosphate, and bromine in an extraction plant at Trona operated by American Potash & Chemical Corp. Stauffer Chemical Co., also extracted sodium borate, sodium carbonate, and sodium sulfate (including glauber salt) from Searles Lake brines at Westend, using a different process. The bromine and potassium salts were sold principally to Los Angeles fertilizer plants. All the calcium chloride produced in the State was recovered from Bristol Lake brines by Leslie Salt Co. (formerly California Salt Co.) and by National Chloride Co. The compound was recovered as a crude liquid, some of which was purchased by Hill Bros. Chemical Co. and converted to a flake product in a nearby plant. Products from the plants were marketed in southern California and adjacent States for fireproofing and hygroscopic uses. Crude solar evaporated salt was harvested at Bristol Lake by Leslie Salt and at Searles Lake by Pacific Salt Co., which had a plant at Danby that was idle in 1963. Leslie also mined halite (rock salt) near Amboy, chiefly for use in making chlorine gas. Metropolitan Water District of Southern California used solar evaporated salt, harvested on its U.S. Sodium Lease near Rice, as a water-softening agent.

Building activity in the Upland and San Bernardino areas and million dollar road construction projects for several sections of Interstate Route 15 between Yermo and the Nevada line required a sand and gravel output of over 7 million tons. About 6 million tons was produced at stationary and portable plants of commercial operators; the remainder was produced by government crews and on-site contractors. Stone output increased about 1.5 million tons compared with 1962. Much of the increase resulted from resumption of full-scale operations at the California Portland Cement Co. limestone quarry at Colton. During the 1961 and 1962 modernization program, the company had used clinker produced at plants in Mojave, Calif., and in Arizona. Limestone was quarried at Oro Grande, Victorville, and Cushenbury for use in agriculture, in the cement, construction, glass, chemical, and other industries which include producers of lime, stucco, poultry grit, and whiting. Marble was quarried near Yucca Valley and Stoddard Wells for building stone and terrazzo. Sandstone, quartz, and quartzite quarries near Oro Grande, Barstow, and Big Bear Lake supplied stone for building, rock wool, filler, and cement use. Comparatively large tonnages of miscellaneous stone and decomposed granite were quarried at several locations and used for riprap, roofing granules, landscaping rock, and road base.

The Iron Age mine, east of Twentynine Palms, was purchased in May and operated the rest of the year by American Exploration & Mining Co. Production was about 10 percent below that of 1962, but shipments rose 26 percent. The mine yielded high-grade lump ore for open-hearth furnaces and lower grade material that was sold to the cement industry. Extensive stripping was underway in prepa-

ration for increased production. The Kaiser Steel Corp. Silver Lake iron property northwest of Baker was idle, but considerable ore was shipped early in the year from stockpile to company furnaces at Fontana. Molybdenum Corp. of America mined and milled bastnaesite ore at its Mountain Pass property. Production of rare-earth concentrates was lower than in 1962, but shipments were higher. Lead ore mined at the C&K claims (Providence area), bullion produced from gold ore at the Fremont Peak property (Randsburg area), and concentrate produced at the Hidden Hill gold mine (Signal area) were shipped to the Selby smelter for recovery of lead, gold, and silver. A few tons of gold ore mined at the Mayday No. 1 claim was treated and some gold recovered. Dump material from various old gold mines was retreated and the concentrates shipped to an Arizona smelter. Stream gravels in the Twentynine Palms area were panned by prospectors who obtained a few ounces of placer gold and silver.

Ball clay was mined at the Hart deposit near Ivanpah by Southern California Minerals Co. and International Pipe & Ceramics Corp. The clay was used in making floor and wall tile. The Honey Brown bentonite property near Vidal was mined by Brown Minerals Co., and the bentonite was sold to producers of animal feeds. Hectorite was mined at the Geyser View claims near Newberry by Inerto Co. for use in clarifying beverages. Hectorite mined near Dagget by National Lead Co. was shipped to the producer's processing facilities in Texas. Miscellaneous clay was mined for use in making cement by Permanente Cement Co. near Lucerne and by Riverside Cement Co. near Oro Grande. Miscellaneous clay for use in making heavy clay products was mined by Pomona Brick Co. near Chino as well as by Hancock Brick Co. near Highgrove. Four companies (Pomona Tile Mfg. Co., Sierra Talc Co., California Minerals, and Western Talc Co.) worked 12 talc deposits in the county and produced about one-third the State output. Except for a relatively small tonnage of crude talc shipped to a San Francisco grinder, all production was consigned to producer grinding plants in the Los Angeles area. The Victorite pyrophyllite deposit near Victorville was idle but shipments were made from stockpile to the C. K. Williams & Co. mill at Victorville. C. K. Williams also operated an experimental lime plant at Lucerne Valley and produced lime for agricultural, chemical, and other industrial uses. The company was expanding the plant to provide full-scale fluidized-bed burning and hydrating operations. Stauffer Chemical Co. burned limestone in a rotary kiln at Westend to provide carbon dioxide for its soda ash production and sold the lime product for construction and chemical uses.

Relatively small quantities of crude oil and wet natural gas were produced from small fields in the extreme southwest section of the county. The output of both commodities decreased 13 percent compared with 1962. Two unsuccessful exploratory wells were drilled in the area.

Volcanic cinder was obtained in the Cima area by Aiken Builders Products and Cima Cinders, Inc., for use principally as lightweight concrete aggregate. Cima Cinders sold some cinder for soil conditioning, roofing granules, and decorative use. John J. Ravese produced volcanic ash from the Williams Bros. deposit in the Opal Mountain area and sold it for use as a soil additive. Polaris Perlite Co., Inc., mined crude perlite near Barstow and shipped it to the producer's Arizona expanding plant. Russel Benedict mined mica (sericite

schist) at the New Frontier prospect near Chubbock and shipped the material to a grinder outside the county.

San Diego.—Sand and gravel production was about 800,000 tons greater than in 1962. Sand and gravel used in building increased 200,000 tons; that for paving increased 600,000 tons. Large quantities were consumed for road base and concrete aggregate in construction of State, county, and city roads, particularly in the San Diego area. Larger tonnages of specialty sands were produced in the Oceanside area and used in glass, foundry, and other industrial uses. Quarries near Escondido supplied much of the granite produced in the State. It was used for monumental and architectural use. Large quantities of building stone, riprap, and base material were obtained from other stone quarries in the same area.

Crude salt was harvested by Western Salt Co. from solar evaporating ponds on South Bay. The company processed the salt in its Chula Vista plant for local customers. Saltworks bitterns were pumped to the nearby FMC Corp. plant, where magnesium chloride was extracted. The City of San Diego Water Department operated a lime-burning operation at its Alvarado water filtration plant and recovered over 4,000 tons of lime from the carbonate sludges precipitated from the Colorado River water. The regenerated lime was recycled through the water treatment system. H. G. Golem mined and shipped pyrophyllite to a Los Angeles chemical company from his Four-Gee mine in the San Dieguito area. Harborlite Corp. mined pyrophyllite from the Harris deposit in the same area and ground it in San Diego, principally for use as a carrier in insecticides. The company also expanded crude perlite, obtained from a Nevada producer, in its Escondido plant. Organic Mineral Sales, Ltd., mined and shipped pyrophyllite from the Pioneer mine (near Harborlite's Harris mine) but did no grinding in 1963. Hazard Block Co. and Union Brick Co. mined miscellaneous clay in the San Diego area and used the materials in making heavy clay products.

San Francisco.—Stone was quarried at Candlestick Point for use as base material. Sand was obtained from dune deposits near the ocean and dredged from the bay for use as fill. Much of the concrete aggregate was shipped by rail from stone as well as sand and gravel producers in other counties.

San Joaquin.—Dry natural gas production rose 80 percent above that of 1962, to more than 40 billion cubic feet. The increase was attributed largely to the Lathrop field, which went on production early in 1963. Two natural gas discoveries were made during the year, one by Occidental Petroleum Corp. in the McMullin Ranch field (11 million cubic feet a day) and the other by Brazos Oil & Gas Co. in the River Island field (6 million cubic feet a day). Some of the county's gas fields recorded production declines. The Vernalis field decreased nearly 1 billion cubic feet compared with 1962 and the McMullin Ranch field registered more than 1 billion cubic feet less. The Galt and Lodi fields had production gains of 18 and 9 percent, respectively, but output was relatively small.

Increased construction activity, particularly road building in Stockton and Lodi, and in adjacent counties, required an appreciably larger tonnage of sand and gravel than in 1962. Commercial plants in the Tracy, Lodi, Clements, Bellota, and Escalon areas supplied a high percentage of the total; the remainder was produced by public works crews and onsite contractors. Holly Sugar Corp. at Tracy and

Spreckles Sugar Co. at Manteca each operated a limekiln on purchased limestone to produce carbon dioxide gas and lime needed in processing sugarbeets. Miscellaneous clays mined near Stockton by California Clay Products Co. and Stockton Building Materials Co. and fire clays produced near Tracy by Pacific Clay Products Co. were used in making heavy clay products. At Lathrop, Best Fertilizer Co. recovered by-product gypsum in the manufacture of phosphoric acid. The product was sold for agricultural use.

Stream gravels along the Mokelumne River were panned by individuals who obtained small quantities of placer gold and silver.

San Luis Obispo.—Crude oil and wet natural gas production declined 3 and 18 percent, respectively, from 1962. The decreases were the result of normal declines at the older fields. Three exploratory wells were drilled in 1963. One reached basement, a second was abandoned as a dry hole, and a third resulted in discovery of the Lopez Canyon oilfield. The discovery well pumped 175 barrels a day of heavy oil. Union Oil Co. of California operated a refinery and sulfur recovery plant at Arroyo Grande, and Richfield Oil Corp. operated two plants at Cuyama to recover natural gas liquids.

Less sand and gravel was produced than in 1962, chiefly because major highway projects were completed early in 1963 and others were not begun until late in the year. Much of the production was by State on-site contractors and county maintenance crews. Commercial sand and gravel preparation plants were operated in the Atascadero, San Luis Obispo, Cambria, Santa Maria, and Oceano areas. The Oceano area also yielded special industrial sands. Limestone was quarried near Arroyo Grande for building construction and near Adelaide for riprap and agricultural use and for sale to beet sugar refineries. Building stone was quarried near Paso Robles. Quartzite was obtained from a quarry near Nipomo for use in making silica brick. Public works crews and contractors and commercial operators quarried riprap and base material at several stone quarries. Superior Gypsum Co. mined and sold agricultural gypsum from its Carisso mine near Simmler during the first part of 1963. San Luis Obispo Brick Co. mined miscellaneous clay near the city limits for its own use.

Underground development was underway at the Buena Vista mercury mine near Klau but no ore was furnaced, and production and shipments of mercury were 43 percent below the 1962 figures. Exploration was reported to have begun at the Keystone mercury property near Cambria.

San Mateo.—Portland cement was produced by Ideal Cement Co. in its Redwood City wet-process plant, using oystershell and clay dredged from San Francisco Bay. Shipments of cement were made by truck, rail, and waterway to California and out-of-State markets. Ideal had the only plant in the State capable of making direct bulk mill shipments by boat or barge. Other companies dredged oystershell from the bay and sold the washed shell to producers of poultry grit and mineral filler for animal feeds. Sand and gravel output was limited to that from streambed deposits along Pilarcitos Creek and that by contractors at various public works project sites. Most of the aggregate produced came from stone quarries where the crushed stone was screened to specification. Basalt was quarried at the Langley Hill quarry near Woodside, and granite was quarried near Pescadero. Limestone was quarried near Rockaway Beach for building construc-

tion along the county coastal area. Sandstone quarried near Brisbane was prepared for aggregate and base material.

Merck & Co. extracted magnesia from seawater in its South San Francisco plant, using a purchased limestone-dolomite mixture as the precipitant. Leslie Salt Co. harvested crude salt from company solar evaporating ponds extending into Alameda and Santa Clara Counties. The salt product from the company Redwood City plant was prepared for out-of-State shipment, principally export. Kaiser Gypsum Co. stockpiled Mexican gypsum at Redwood City, chiefly for sale and use in making portland cement.

Crude oil production dropped more than 20 percent, and wet natural gas output declined 26 percent, compared with 1962 figures. One of the county's three fields (Half Moon Bay) was shut in during 1963, and production was divided between the La Honda field (97 percent) and the Oil Creek field (3 percent). Three exploratory drilling attempts were unsuccessful.

Santa Barbara.—Fields within the county yielded 3 percent more crude oil, 12 percent more wet natural gas, and 241 percent more dry natural gas than in 1962. The marked rise in dry-gas output was credited primarily to the development of the Molino Offshore field (discovered in 1962) in which six new productive wells were completed in 1963. The gas yield from this field alone was more than 5 billion cubic feet. Other offshore dry gasfields contributing substantially to the increase were the Caliente (also discovered in 1962), Gaviott Naples, and Cuarta Canyon. At South Cuyama, a combined natural gas-liquid petrolem gas miscible-phase pressure-maintenance project was commenced, and at Capitan a peripheral waterflood was underway. Other secondary recovery projects were carried on at Casmalia, Cat Canyon, Orcutt, Santa Maria, and Zaca Creek. Four exploratory wells were drilled; all were unsuccessful. Six plants were operated to extract natural gas liquids from wet natural gas, and production rose 24 percent above that of 1962. At Santa Maria, refineries were operated by Douglas Oil Co. of California and Union Oil Co. of California.

Near Lompoc, Johns-Manville Products Corp. and Great Lakes Carbon Corp. mined and processed diatomite for filler, filtration, and insulation uses. The Airox Co. mined and processed diatomite for lightweight aggregate and pozzolan near Santa Maria. Diatomic Chemical Co. (new) mined diatomite from a deposit a few miles north of Lompoc and ground, calcined, and screened the material for sale as an absorbent.

Combined production of sand and gravel and stone was less than in 1962, primarily because of completion of highway projects and reduction in the construction rate at Vandenburg Air Force missile base and the Navy's Point Arguello missile site. Commercial sand and gravel preparation plants operated on the Santa Maria and Santa Ynez Rivers. Sandstone and miscellaneous stone were quarried in the Santa Maria, Lompoc, and Santa Barbara areas for building and ornamental use, riprap and concrete aggregate, and base material. Stone from the Rincon quarry, near the Ventura County line, was used for riprap in ocean-front embankment protection. Union Sugar Division, Consolidated Foods, burned purchased limestone at Betteravia to obtain carbon dioxide gas and lime used in processing sugar beets.

Santa Clara.—Permanente Cement Co. produced portland cement at Permanente for shipment in bulk and bags to customers in California,

Oregon, Washington, Nevada, Alaska, and Pacific Island possessions. Increased building and paving activity at new residential subdivisions and several highway construction projects were directly responsible for a greater output than that of 1962 of sand and gravel as well as stone for aggregate and base material. The principal sand and gravel preparation plants were in the San Jose, Santa Clara, Cupertino, and Morgan Hill areas. Smaller plants were near Gilroy and Coyote. Nearly 5 million tons of stone was quarried near San Jose and Saratoga for aggregate and base material. Limestone quarried in the Los Altos hills was used in making cement. Dimension building stone was obtained from quarries near San Jose and Mountain View. Permanente mined clay in the Cupertino area and used it in making cement. Remillard-Dandini Co. mined miscellaneous clay near San Jose and sold it for making heavy clay products. The Lone Hill volcanic cinder deposit near Los Gatos was idle.

Although seven lessees worked sections of the New Almaden mercury mine, 84 percent of the production came from Andy's Mercury Reduction Plant (San Francisco lease). Combined output (all leases) from the mine was 7 percent below that of 1962. At the neighboring Guadalupe mine, Palo Alto Mining Corp. retorted ore and recovered mercury.

Santa Cruz.—Portland cement was produced by Pacific Cement & Aggregates, Inc., in its Davenport plant, using shale and limestone from its own quarries near Davenport. Shipments of bulk and bagged cement were made by truck and rail principally to the producers ready-mixed concrete operations in northern California. Ideal Cement Co. quarried shale near San Juan Bautista for use at its cement plant.

Large quantities of sand were obtained near Felton and shipped by truck and rail to customers in the San Francisco Bay area counties for use in concrete and plaster. Sand from the Scotts Valley area and sand and gravel produced near Santa Cruz were used in local building and paving projects. County crews worked local gravel deposits for material used in road maintenance. The stone output was appreciably greater than in 1962 because of increased demand for granite from the Felton and Soquel areas in construction of buildings and roads. At Santa Cruz, limestone was quarried for rubble and prepared for poultry grit. Public works crews and contractors quarried stone in several areas for roadstone and for riprap used as shoreline protection.

Shasta.—Portland cement was produced by Calaveras Cement Co. in its Redding plant and shipped to customers in northern California, Nevada, Oregon, and Washington. The company was a major supplier of cement to contractors working on hydroelectric projects in Shasta County. Calaveras Cement mined clay near Redding and limestone from its Gray Rock quarry for use in making cement. Some limestone was sold to sugar companies.

Sand and gravel production declined about 300,000 tons from the 1962 figure despite increased demand for structural use. Paving requirements were less as some major road projects were completed early in the year and new projects were not yet underway. Relatively large tonnages of sand and gravel were produced and prepared at commercial stationary and portable plants and by public works crews and contractors. Most of the material was used in local construction, in Bureau of Reclamation irrigation and power projects, and in prep-

747-416—64——15

aratory construction work for the Pacific Gas & Electric Co., $92 million McCloud-Pit River hydroelectric project. Less stone was quarried than in 1962 because of lower demand for riprap and roadstone in Federal and county road projects. State highway crews and contractors mined volcanic cinder for use in road maintenance. Volcanic cinder was obtained near Glenburn and by Sanford Sand and Gravel southwest of Fall River Mills for local road repair. Stewart Masonry Supply mined volcanic cinder from the Black Butte deposit for use as lightweight concrete aggregate. Al Rossi worked the Loftus barite claims and shipped crude barite to a Sacramento County grinding plant.

Mountain Copper Co. mined and shipped (and shipped from stockpile) magnetite ore from its Iron Mountain open-pit mine to a domestic iron and steel plant. Yearend stocks were appreciably reduced from those of 1962. Gold ore from two properties near French Gulch was treated and small quantities of gold and silver were recovered. Gold ore mined at the Jumbo property near Redding was upgraded before shipment to the Selby smelter where gold and silver were recovered. Byproduct placer gold and silver were recovered in the Shea Sand and Gravel nonfloating washing plant near Redding. Stream gravels in the Igo, French Gulch, Redding, and Shasta areas were worked by prospectors who used small-scale hand methods to recover placer gold and silver.

Sierra.—Sand and gravel was produced by public works crews and contractors for repair and maintenance of State, county, and National Forest roads. Quartz was quarried and shipped from Crystal Peak to an Oregon silicon plant.

Several lode gold mines were active part of the year but only the Brush Creek mine near Goodyears Bar and the Original 16 to 1 mine at Alleghany yielded significant quantities of gold and silver. However, much gold and some silver was recovered at the Good Hope property in Alleghany from 500 tons of previously mined ore. Rex Sierra Gold Corp. recovered placer gold and silver by hydraulicking from about 10,000 cubic yards of ancient river bed gravels at the Pleasant View claims near Pike. Old tailings were treated at two placer properties in the Poker Flat area and some placer gold and silver was recovered. More than three-fourths of the 1963 placer gold and silver was recovered by individuals who worked stream gravels in the Alleghany area, using small-scale hand methods.

Siskiyou.—More sand and gravel was produced by commercial operators and by Government crews and contractors than 1962. Much of the material was used for building and paving purposes, particularly on a section of U.S. Highway 99 north of Mount Shasta. Relatively large tonnages of miscellaneous stone were quarried for road construction within the National Forest by the U.S. Bureau of Public Roads. Dimension building stone and roofing granules were prepared at a stone quarry near Montague. More than half the volcanic cinder mined came from the Kegg pit near Bray and was used for railroad ballast. State and county road crews produced and prepared nearly 40,000 tons of volcanic cinder for use in the construction, repair, and maintenance of roads. Several concrete block companies mined volcanic cinder for use as lightweight aggregate. Pumice was mined from the Long Haul claims near Tionesta and was prepared for lightweight concrete aggregate by Glass Mountain Block, Inc.

A dragline operation at the Humbug claims on the Klamath River yielded 1,088 ounces of gold and 175 ounces of silver out of a total 1,155 ounces of gold and 188 ounces of silver reported from all placer operations. Individuals who worked stream gravels on the Klamath, Salmon, and Scott Rivers by panning and sluicing recovered the remainder.

Solano.—Solano County was second only to Sacramento County in output of dry natural gas. The yield was 21 percent above that in 1962. The increase was attributed to larger withdrawals from older fields. Little development drilling was undertaken during the year. One discovery was not yet in production and another yielded less than 1 billion cubic feet of gas. The discoveries were made by S. M. Reynolds (Dixon field) and Amerada Petroleum Corp. (Lindsay Slough field). The Bunker field led with a production increase of 6 billion cubic feet over 1962 production, whereas the Liberty Island and Maine Prairie fields showed gains of 2.5 billion and 200 million cubic feet, respectively. A few wells yielded small quantities of crude oil, about one-third of the 1962 volume.

Sand and gravel was produced at commercial portable and stationary plants in the Benicia and Winters areas, and by State and county contractors for road construction projects. Stone was quarried for roadstone and base material near Thomasson, Benicia, and Vallejo. The Tolenas Quarry Co., near Fairfield, crushed travertine and supplied terrazzo chips and rubble for building construction.

Sonoma.—Sand and gravel production declined several hundred thousand tons from that of 1962, chiefly because major sections of freeway projects near Healdsburg were completed. However, road construction was still in progress in the Santa Rosa and Cloverdale areas. Demand was high for building sand and gravel. Stationary and portable preparation plants operated along the Russian River; most of these plants scalped off the plus 1.5-inch gravel then washed and screened the undersize. Stone quarries near Petaluma, Sonoma, Cotati, Forestville, and Occidental supplied much of the riprap for river embankments and base material for road and building foundations. Dimension stone was quarried near Glen Ellen for building and flagging use. Shale was quarried near Calistoga and used for fill in road construction.

Dump material was furnaced at the Culver-Bear property in the Geysers area, and about 200 flasks of mercury was recovered. Much ore was mined during the year, but only a comparatively small tonnage of this ore was furnaced. Ore from the Eagle Rock lease on the Culver-Bear property, however, was furnaced, and a few flasks of mercury were recovered. The operator of the Eagle Rock lease was driving a new adit as part of a development program. Ore from the Socrates and West Coast (Eureka) mercury mines in the same area was retorted and some mercury was recovered.

The county's entire natural gas output came from the Petaluma dry gasfield. Production was 57 percent below the 1962 yield.

Stanislaus.—Over 1 million tons of sand and gravel was produced and prepared for building construction, road and street projects, and railroad ballast. Demand for paving aggregate was higher than in 1962 because of State highway work in the Modesto and Ceres areas. Commercial sand and gravel plants operated along the Stanislaus and Tuolumne Rivers using a variety of equipment to work the streambed and alluvial deposits. Ball clay and miscellaneous clay were mined

in the Oakdale and Knights Ferry areas by E. H. Metcalf and Western States Materials. The ball clay was sold for use in making whiteware; the miscellaneous clay was used in heavy clay products. Fire clay was mined near LaGrange by Kraftile Co. for use in making heavy clay products.

Nonfloating sand and gravel washing plants, one on the Stanislaus River near Oakdale and another on the Tuolumne River near LaGrange recovered byproduct placer gold and silver. A few ounces of these metals also were recovered by individuals who panned stream gravels along the Stanislaus River.

FMC Corp. prepared barite for use by the glass industry in its plant near Modesto. The crude ore was produced at a company mine in Nevada.

Sutter.—Output of dry natural gas was nearly double the 1962 volume. Much of the increase was from the Grimes field (half of which lies outside the county), which produced 11 billion cubic feet more than in 1962, despite the fact that only one development well was drilled in 1963. Twenty new development wells in the Sutter (Marysville) Buttes field were largely responsible for the 5 billion cubic feet of increased output from that field. Two new wells in the Sutter City field contributed notably to the nearly 2.5 billion cubic feet of increased production there. Six exploratory wells were drilled in 1963, resulting in one discovery when G. R. Scott extended the Butte Slough field with his well completion.

Gravel deposits in the Sutter Buttes area were worked by commercial operators and public works contractors to obtain road base and building foundation material. Most concrete aggregate requirements were met by suppliers in Yuba County. International Pipe & Ceramics Corp. mined miscellaneous clay near Nicolaus and used the material in making heavy clay products. At Sutter, Yuba Minerals & Milling Co. operated a grinding plant to process nonmetallic minerals for its own use and to provide custom grinding for other companies.

Tehama.—Sand and gravel production dropped nearly 2 million tons from 1962 principally because of completion of major water system projects by the U.S. Army Corps of Engineers and the Bureau of Reclamation. A large part of the 1963 output was used in the repair and maintenance of county and State roads, particularly a section of U.S. Highway 99 north of Red Bluff. Commercial stationary and portable sand and gravel preparation plants operated along the Sacramento River and Thomas Creek. About 29,000 tons of stone was quarried for rubble, riprap, and roadstone by public works contractors. Pumice was mined by the operator of Blue Rock Quarries and sold for decorative use (landscaping). State highway crews obtained volcanic cinder at various pits for use in the repair and maintenance of roads.

Three dry gasfields yielded more than 1 billion cubic feet of natural gas, 42 percent less than in 1962. The percentage drop was virtually the same in all three fields. Development drilling did not result in any production increases. Eight exploratory wells were drilled resulting in one discovery, the Rice Creek field, which was opened by Sunray DX Oil Co. when a well completion produced a flow rate of about 3.3 million cubic feet of gas a day.

Small quantities of placer gold and silver were recovered by individuals who panned stream gravels along the Sacramento River near Bend.

Trinity.—More sand and gravel was produced than in 1962. Preparation plants were operated by commercial producers and Government contractors in the Weaverville and Douglas City areas to provide the materials for road construction. Granite and miscellaneous stone were quarried by the Northern Pacific Railroad and Bureau of Reclamation contractors for use as riprap.

Ore from two lode gold mines in the Hayfork area was treated by amalgamation and the resulting bullion was shipped to the U.S. Mint. Three hydraulic operations and two suction dredges recovered placer gold and silver from stream, bench, and ancient river bed gravels along the Trinity River. Individuals worked stream gravels of the Trinity and New Rivers and recovered small quantities of placer gold, some of which contained recoverable silver.

Tulare.—The Door Creek oilfield and a portion of the Trico dry natural gasfield were the sources for the county's entire output of these commodities. Crude oil production rose 22 percent, whereas the natural gas yield was 2 percent lower. Three new wells were completed during the year, all in the Deer Creek field, and five unsuccessful exploratory wells were drilled, one of which reached basement.

Of the total sand and gravel production, by stationary commercial plants along the Kaweah and Tule Rivers and by Government crews and contractors, nearly 1 million tons was used in road construction in the Porterville and Visalia areas. The balance was used in local building and paving projects and in the construction of facilities in Sequoia National Park. Limestone was quarried near Orosi for rough and dressed building stone, and near Porterville for use as a mineral filler. The U.S. Forest Service and State highway contractors quarried granite and miscellaneous stone for embankment protection and roadstone.

Macco Corp. mined barite from its Barite King property in 9-mile Canyon and upgraded some of the ore in an Inyo County jigging plant before shipment to its Rosamond grinding facility in Kern County. S. P. Brick Co. mined miscellaneous clay near Exeter and used it in making heavy clay products.

Tuolumne.—Sand and gravel as well as stone for rubble and riprap were produced by contractors for the Hetch Hetchy water supply system and as well as State and county road agencies. Limestone was quarried at Columbia and Sonora by U.S. Lime Products Division, The Flintkote Co. The company used the stone to produce lime for agriculture and the construction, chemical, and other industries. Some limestone also was sold to the glass industry and for agricultural use. Large tonnages of roadstone and drain rock were produced at the Tunes quarry near Twain Harte. Sonora Marble Aggregates Co. and R. K. Hatch used marble in the Sonora area. The former prepared the marble for terrazzo; the latter produced rough building stone. County road crews mined volcanic cinder and prepared its for use in road maintenance and repair. Pacific Clay Products Co. quarried shale near Sonora and used it in making heavy clay products.

Garn L. Moody mined uranium ore at his Juniper mine near Pinecrest and shipped it to a processing plant in Utah. Ore containing recoverable gold and silver was shipped from the Hidden Fortune prospect in the Columbia area to the Selby smelter, Contra Costa County. George Miller recovered gold and silver from ores of the

Golden Star mine near Saw Mill Flat and the Golden Rule claims near Jamestown. Free gold was recovered from the Fenton claims in the Oak Flat area. Stream gravels were worked by dragline excavator in the Woods Creek area and by suction dredge near the junction of the north fork of the Tuolumne River to obtain placer gold and silver. A few ounces of placer gold was recovered by individuals who panned stream gravels at various locations.

Ventura.—Crude oil production declined 9 percent, and the associated wet natural gas yield dropped 14 percent from the 1962 figures. Less than 6 billion cubic feet of dry gas was produced. The major crude oil decline was in the Ventura field (over 1 million barrels) although outputs in the South Mountain, Rincon, Oxnard, Saticoy, and Filmore fields decreased 250,000 to 500,000 barrels each. Small to moderate production gains were reported in the Sespe, Torrey Canyon, and San Miguelito oilfields. As expected, the largest volume decline in wet natural gas was in the Ventura field, but lower yields also were recorded in the West Montalvo, South Mountain, Saticoy, and Oxnard fields. None of the fields had notable gains in wet gas production, the largest being about 500 million cubic feet. Ten natural gas liquids plants collectively extracted 200 million gallons, 9 million less than in 1962. Exploratory drilling activity resulted in one new oilfield discovery. Union Oil Co. of California established the new Santa Susana field with a well completion that flowed more than 300 barrels daily of 35 degree API crude oil.

Pit-run and prepared sand and gravel were produced by commercial operators and by Government crews and contractors. The total output was less than in 1962, primarily because major highway projects were completed and new projects, particularly a large section of a new road near Santa Paula, had only reached the grading and subbase stage by yearend. Large tonnages of stone were quarried near Moorpark, Camarillo, Rincon, and Oxnard for use as base course material. Stone also was quarried from the latter two areas for riprap in shoreline protection, and in the construction of new facilities at several military installations. Dimension building stone was quarried near Fillmore. A new crushing plant was erected on San Nicholas Island, 70 miles southeast of Port Hueneme.

Oystershell from the ancient Tapo Alto deposit was worked for use as a mineral filler in animal feeds and fertilizer and for poultry grit. Shale was quarried near Ventura by Rocklite Products, Inc., and near Frazier Park by Ridgelite Products, Inc. Both producers expanded the shale for use as lightweight aggregate. Monolith Portland Cement Co. mined gypsum at its Cuyama deposit for use as a cement retarder in its Kern County Cement plant.

Yolo.—Commercial producers operated stationary and portable sand and gravel washing plants near Madison, Yolo, and Woodland. Output of sand and gravel was appreciably above that in 1962. Demand was mostly for concrete aggregate and base material both within and outside the county. Production came principally from streambed deposits along Cache Creek. Public works crews produced sand and gravel for use in road maintenance and repair. American Crystal Sugar Co. at Clarksburg and Spreckles Sugar Co. at Woodland, each burned purchased limestone for carbon dioxide gas and for lime used in processing sugar beets.

Dry natural gas production increased slightly from 1962, and came principally from the Winters field, which straddles the Yolo-Solano

County line. Yields from the Dunnigan Hills and Sycamore Slough field were lower by 85 million and 2 million cubic feet, respectively. Occidental Petroleum Corp. made a new discovery when a well completion opened the Clarksburg gasfield. The discovery well flowed 36.7 million cubic feet a day.

Yuba.—Bucketline dredging by Yuba Consolidated Gold Fields, on the Yuba River in the Marysville area, produced most of the State's placer gold and silver. The company was California's leading gold producer and the only producer of platinum-group metals, which were recovered as a byproduct of gold dredging. The balance of the County placer gold and silver output was recovered by individuals who sluiced and panned stream gravels in the Camptonville, Brownsville, Smartville, and Browns Valley areas. Paramount Mining & Development Co. mined gold ore from the Dannebroge mine near Browns Valley and the Good Hope mine in the Smartville area. The ores were milled and the concentrates were shipped to the Selby smelter for recovery of gold and silver. The Good Hope ore also contained recoverable copper.

Sand and gravel was obtained from streambed deposits and dredge tailings along the Yuba River for concrete aggregate and road base. Some sands were prepared from these sources for sale as blasting and engine sands. Large quantities of sand and gravel were produced for paving and structures at Federal, State, and county construction projects. Much sand and gravel from Yuba County was supplied to customers in Sutter County. A relatively small tonnage of miscellaneous stone was quarried by State highway contractors and used for riprap and base material. International Pipe & Ceramics Corp. dug miscellaneous clay near Wheatland and used it in making drain tile and sewerpipe.

The Mineral Industry of Colorado

By D. H. Mullen [1]

MINERAL production in Colorado in 1963 was valued at $317.1 million, a 3-percent gain over that of 1962. Of the 34 minerals and mineral fuels produced in Colorado, 17 gained in value of output and 17 declined in value of production. Uranium mine and mill operators, following the announcement of the stretchout program by the U.S. Atomic Energy Commission (AEC) in November 1962,

TABLE 1.—Mineral production in Colorado [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate---short tons, gross weight	782	(2)	751	(2)
Carbon dioxide, natural---thousand cubic feet	148,940	$15	224,856	$38
Clays---thousand short tons	802	1,573	686	1,334
Coal (bituminous)---do	3,379	19,999	3,691	21,888
Copper (recoverable content of ores, etc.)---short tons	4,534	2,793	4,169	2,568
Gem stones	(3)	45	(3)	63
Gold (recoverable content of ores, etc.)---troy ounces	48,882	1,711	33,605	1,176
Gypsum---thousand short tons	108	383	99	346
Lead (recoverable content of ores, etc.)---short tons	17,411	3,204	19,918	4,302
Lime---thousand short tons	93	1,518	128	2,104
Mica (scrap)---short tons	142	2	440	7
Molybdenum (content of concentrate) thousand pounds	32,412	45,376	47,977	67,168
Natural gas---million cubic feet	101,826	11,812	105,705	12,367
Natural gas liquids:				
LP gases---thousand gallons	100,787	4,411	91,309	4,171
Natural gasoline and cycle products---do	60,558	3,826	56,869	3,191
Peat---short tons	12,351	68	13,774	98
Petroleum (crude)---thousand 42-gallon barrels	42,477	122,334	[4] 38,271	[4] 110,220
Pumice---thousand short tons	76	82	60	87
Sand and gravel---do	19,313	18,926	20,385	20,929
Silver (recoverable content of ores, etc.) thousand troy ounces	2,088	2,265	2,307	2,951
Stone---thousand short tons	2,353	5,597	2,510	5,693
Uranium ore---short tons	1,135,440	18,044	1,014,206	15,864
Vanadium---do	3,742	(2)	3,047	(2)
Vermiculite---thousand short tons	(2)	(2)	(5)	1
Zinc (recoverable content of ores, etc.)---short tons	43,351	9,971	48,109	11,065
Value of items that cannot be disclosed: Cement, feldspar, fluorspar, iron ore, perlite, pyrites, salt, tin, tungsten concentrate, and values indicated by footnote 2		[6] 34,209		[7] 29,478
Total		[8] 308,164		317,109

[1] Production as measured by mine shipments, sales or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Weight not recorded.
[4] Preliminary figure.
[5] Less than 500 tons.
[6] Value of metals, $14,632,000; value of nonmetals, $19,577,000.
[7] Value of metals, $11,653,000, value of nonmetals, $17,825,000.
[8] Revised figure.

[1] Mining engineer, Bureau of Mines, Denver, Colo.

TABLE 2.—Value of mineral production in Colorado from 1858 through 1963, by commodities

Commodity	Value (millions)	Commodity	Value (millions)
Petroleum (crude)	$1,899	Natural gas and natural gas liquids	$145
Coal (bituminous)	1,374	Stone	108
Gold	918	Copper	102
Molybdenum	882	Tungsten	49
Silver	607	Fluorspar	38
Zinc	389	Clays	24
Lead	338	Radium	20
Sand and gravel	208	Other [2]	15
Vanadium	200		
Uranium ore [1]	189	Total	7,670
Cement	165		

[1] For 1948 through 1963; prior value included in "Other."
[2] Includes beryllium concentrate, carbon dioxide, feldspar, gypsum, iron ore, lime, mica, peat, perlite, pyrites, pumice, salt, tin, and vermiculite.

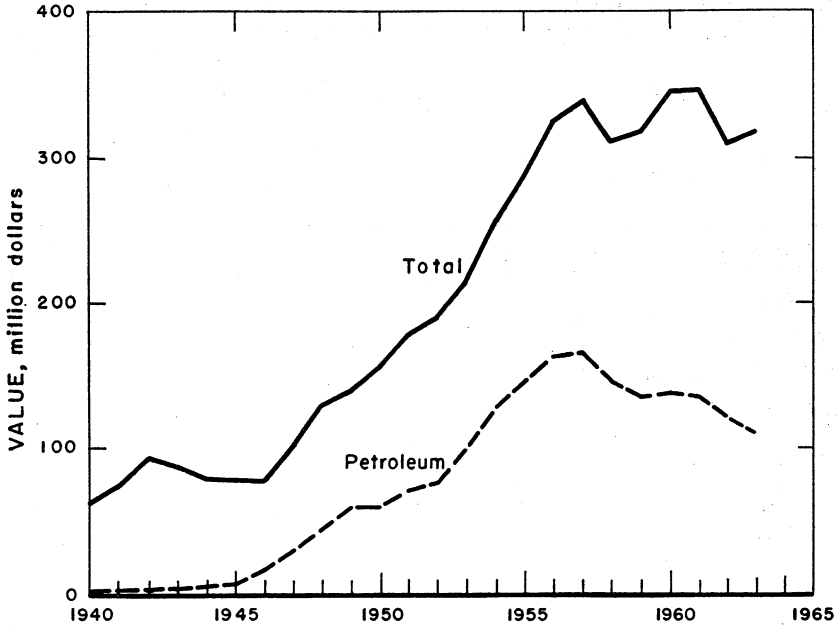


FIGURE 1.—Value of petroleum, and total value of mineral production in Colorado, 1940–63.

adjusted production schedules to meet the reduced requirements for uranium oxide.

Production value of the mineral fuels represented 48 percent of the total value of mineral production in the State. A 9-percent increase in the value of bituminous coal was the highest since 1951. The increase was largely consumed by thermal powerplants.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is con-

TABLE 3.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$218,492	1958	$308,961
1953	236,253	1959	318,983
1954	281,197	1960	344,134
1955	307,833	1961	343,563
1956	335,690	1962	302,633
1957	335,070	1963	306,325

structed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Employment and Injuries.—Table 4, compiled from data collected by the Federal Bureau of Mines, shows employment and injuries in the mineral industries for 1962 and 1963, excluding the mineral fuels except coal. Data for 1962 are final; data for 1963 are preliminary.

TABLE 4.—Employment and injuries in the mineral industries [1]

Industry	Number of operations	Average number of men employed	Total man-hours worked	Injuries		Frequency rate (injuries per million man-hours)
				Fatal	Non-fatal	
1962:						
Nonferrous mines, mills and smelters (excluding uranium)	191	1,418	2,497,818	1	155	62.5
Uranium mines and mills	306	2,366	4,382,529	3	146	34.0
Ferrous mines and mills	11	846	2,077,555	2	57	28.4
Sand and gravel plants	213	1,016	1,857,430	1	48	26.4
Sand quarries and plants	188	781	1,265,644		33	26.1
Nonmetal mines and mills (other than sand and gravel and stone)	117	423	592,856		13	21.9
Coal and coke	115	1,824	2,874,340	3	122	43.5
Total	1,141	8,674	15,548,172	10	574	37.6
1963: [2]						
Nonferrous mines, mills and smelters (excluding uranium)	232	1,483	2,385,998	2	146	62.0
Uranium mines and mills	344	1,995	3,180,764	1	88	28.0
Ferrous mines and mills	10	1,146	3,234,755		72	22.3
Sand and gravel plants	315	1,046	1,835,599		28	15.3
Stone quarries and plants	249	899	1,388,301	1	44	32.4
Nonmetal mines and mills (other than sand and gravel and stone)	98	437	654,913		6	9.2
Coal and coke	103	1,564	2,687,043	1	76	28.7
Total	1,351	8,570	15,367,373	5	460	30.3

[1] Excludes employees in all mineral fuels industries except the coal industry, as well as officeworkers.
[2] Preliminary figures.

Government Programs.—The Office of Minerals Exploration (OME) approved four contracts for exploring mineral deposits in Colorado. Under the exploration assistance program, the OME participated in the cost of exploring for selected mineral commodities. Funds furnished by the Government representing 50 percent of the cost of specified exploration activities were to be repaid by a royalty on subsequent production.

Bulldog Mountain, Inc., San Francisco, Calif., obtained assistance in exploring a silver deposit in the Sunnyside district, Mineral

County. Consisting of extensive drifting, crosscutting, and underground diamond drilling, the work was estimated to cost $212,320.

Frank O. Richardson contracted with OME to explore a gold-silver deposit near Ouray, San Juan County, by drifting, crosscutting, and raising at an estimated cost of $57,300.

In Clear Creek County, Kenneth E. & Genevieve Baker were assisted in exploring the Clifford mine for molybdenum. Exploration of the deposit, estimated to cost $45,952, was by diamond drilling from surface structure.

Richmond Hill Exploration Co., Inc., Aspen, contracted with OME to explore for silver in the Highland mining district, particularly in the Richmond Hill area including the Little Annie and Midnight mines in Pitkin County. The exploration work through underground openings was estimated to cost $289,455.

The Federal Bureau of Mines—with offices and laboratories at Denver and field offices and operating groups at Tucson, Ariz.; Socorro, N. Mex.; Salt Lake City, Utah; and Laramie, Wyo.—continued its widespread and comprehensive investigation of mineral deposits, coal utilization, and engineering research of the mineral industry in Arizona, Colorado, Nebraska, New Mexico, North Dakota, South Dakota, Utah, and Wyoming.

Mineral resource studies were made of bituminous coal in Colorado; petroleum in the Rocky Mountain and Northern Plain States and Alaska; and metal and nonmetal mineral resources including mining methods, uses, and statistics relating to production, employment, and injuries in the entire area.

The Bureau of Mines also made mineral investigations and economic evaluations in specific areas as a service agency for the Area Redevelopment Administration, Office of Minerals Development; Federal Bureau of Reclamation; U.S. Army Corps of Engineers; and other; agencies included in the Missouri River Basin development.

The Denver Mining Research Center continued its long-term research program in rock mechanics applied to ground stabilization and control; the physics of earth structures; the development of engineering principles and mathematical techniques applicable to the exploration, development, and operational problems of mining. A General Electric 225 computer, installed late in 1962, was used extensively.

The Denver Coal Research Laboratory, continuing its comprehensive research program, investigated the properties and uses of Western coals, including entrainment carbonization, carbonization assays, and physical and chemical properties of coals and coal products. The investigations were confined mainly to Western bituminous coals. A report of investigations [2] was published.

Water.—The Bureau of Mines conducted a census of the consumption of water in the mineral industry for 1962. Table 5 shows the water use in Colorado for the entire mineral industry; table 6 shows, in more detail, water used for oil- and natural-gas-well drilling. The data presented are based on responses received, with estimates where necessary.

---

[2] Landers, W. S., Manuel Gomez, and E. O. Wagner. Coking-Rate Study on a Commercial Blend of Western Coals. BuMines Rept. of Inv. 6289, 1963, 26 pp.

TABLE 5.—Water used during 1962 in the mineral industry, by type of operations

(Million gallons)

Type of operation [1]	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	1		1	1		.18
Coal mines	5	15	20	4	1	3.05
Metal mines and mills	7,682	3,497	11,179	5,832	1,850	91.96
Nonmetal mines and mills	649	89	738	564	85	189.24
Sand and gravel operations	1,537	2,838	4,375	1,321	216	81.32
Natural gas processing plants	281	22,659	22,940	105	176	42.51
Total	10,155	29,098	39,253	7,827	2,328	
Oil- and natural-gas-well drilling			168			
Secondary-recovery operations			3,732			
Total			3,900			
Grand total			43,153			

[1] Water survey did not include cement plants, lime plants, metal smelters, metal refineries, petroleum refineries, natural-brine operations, sand and gravel operations using suction dredges without preparation plants, stockpile operations, and assessment work operations.

TABLE 6.—Water used during 1962 or oil and natural gas wells drilled, by counties

County	Number of wells	Total footage drilled (feet)	Fresh water used	Saline water used	Other water used	Total water used	Total barrels per foot
			(42-gallon barrels)				
Adams	31	173,468	216,835			216,835	1.25
Archuleta	7	40,151	50,000			50,000	1.25
Baca	34	162,764	288,092			288,092	1.77
Bent	5	23,544	47,794			47,794	2.03
Costilla	1	1,005	1,126			1,126	1.12
Delta	1	793	888			888	1.12
Dolores	1	8,922	38,000	15,000		53,000	5.94
Elbert	4	16,009	17,930			17,930	1.12
Fremont	1	1,912	1,800			1,800	.94
Garfield	5	31,706	56,437			56,437	1.78
Grand	1	7,882	11,980			11,980	1.52
Gunnison	1	3,406	3,815			3,815	1.12
Jackson	13	77,215	191,500			191,500	2.48
Kiowa	6	26,910	50,053			50,053	1.86
Kit Carson	1	5,512	4,000			4,000	.73
La Plata	61	323,712	116,536			116,536	.36
Larimer	2	12,668	14,188			14,188	1.12
Logan	74	376,356	391,410			391,410	1.04
Mesa	12	65,796	91,456			91,456	1.39
Moffat	30	184,013	228,812		102,411	331,223	1.80
Montezuma	11	39,068	43,756			43,756	1.12
Montrose	2	22,593	130,136			130,136	5.76
Morgan	72	412,841	235,319			235,319	.57
Pitkin	1	410	459			459	1.12
Prowers	4	21,077	32,955	5,194		38,149	1.81
Rio Blanco	45	181,457	61,695			61,695	.34
Rio Grande	1	4,768			20,000	20,000	4.19
Routt	7	33,477	37,494			37,494	1.12
San Juan	4	3,517	1,354			1,354	.38
San Miguel	1	10,150	11,368			11,368	1.12
Sedgwick	3	10,702	13,176			13,176	1.23
Washington	260	1,188,872	1,224,538			1,224,538	1.03
Weld	49	326,254	146,814			146,814	.45
Yuma	15	68,059	98,686			98,686	1.45
Total	766	3,866,989	3,860,402	20,194	122,411	4,003,007	[1] 1.04

[1] Average.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

The value of the mineral fuels—carbon dioxide, coal, natural gas, natural gas liquids, peat, and crude petroleum—was $152 million, a decline of $10.5 million or 6 percent compared with that of 1962. The value of all the mineral fuels represented 48 percent of the total value of mineral output in the State. Declines were recorded in the value of crude petroleum and natural gas liquids; gains were noted in the value of coal, natural gas, peat, and carbon dioxide.

Asphalt and Related Bitumens (Gilsonite).—American Gilsonite Co. operated its refining plant at Gilsonite at capacity throughout the year. Gilsonite, mined in Utah, was transported through a 72-mile pipeline to the plant where metallurgical coke, gasoline, diesel fuel, and other products were produced. Metallurgical coke was shipped to consumers throughout the free world; gasoline and diesel fuel output were marketed locally. Specialty products used for insulation and paving and ground gilsonite for various uses also were marketed throughout the world.

Carbon Dioxide.—Natural carbon dioxide gas from the Nina View field in Las Animas County and the McElmo field in Montezuma County was processed at plants in Bent and Montezuma Counties. The gas was compressed and chilled to form liquid carbon dioxide and Dry Ice for use as a refrigerant and for other industrial uses. Part of the gas was compressed and marketed in cylinders for use in soda fountains and at bottling works in preparing carbonated drinks. The output was 51 percent above that of 1962 and the value more than 2½ times greater. Carbon dioxide produced with crude petroleum at the McCullum field in Jackson County was vented.

Coal (Bituminous).—Output of bituminous coal from 82 mines—74 underground, 8 strip—was 3.7 million tons: an increase of 9 percent, compared with that of 1962 and the largest since 1951 when 4.1 million tons was produced. Much of the gain was from strip mines in Routt County and underground mines in Las Animas and Pitkin Counties. Greater consumption at steel plants in Colorado and Utah and a marked increase in the coal used at thermal powerplants accounted for the gain.

The $30.5 million 150,000-kilowatt powerplant being built near Hayden in Routt County by Colorado-Ute Electric Association was 35 percent completed at the end of the year. Construction of the plant, first of four such units planned for the site, began in April; the 250-foot smokestack, steel structure for the main 12-story building to house the boiler plant and generator, coal crusher, and outside paneling were completed. Installation of equipment was scheduled for 1964, with initial power generation by January 1965. Adjacent to the plant, an open-pit mine operated by Peabody Coal Co. of St. Louis, Mo., was to be the coal source. An estimated 500,000 tons was to be consumed annually by the first unit.

TABLE 7.—Coal (bituminous) production, by counties

(Excludes mines producing less than 1,000 short tons)

County	1962		1963	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Delta	65,471	$5.41	34,407	$5.79
El Paso	[2] 508,396	[2] 7.71	[3] 737,049	[3] 7.54
Fremont	331,370	3.71	321,966	3.78
Garfield	10,698	7.32	8,266	7.48
Gunnison	195,021	6.57	156,314	5.95
Huerfano	43,833	5.51	42,627	6.52
La Plata	30,008	3.64	25,006	4.30
Las Animas	680,907	9.47	772,396	9.54
Mesa	112,256	5.41	78,462	5.45
Moffat	128,087	4.66	[3]	[3]
Montrose	[2]	[2]	[3]	[3]
Pitkin	[2]	[2]	[3]	[3]
Rio Blanco	[2]	[2]	6,587	6.33
Routt	486,896	3.80	786,401	3.49
Weld	786,457	4.17	721,031	4.11
Total	3,379,400	5.92	3,690,512	5.93

[1] Value received or charged for coal f.o.b. mine, including selling cost. (Includes a value for coal not sold but used by producer, such as mine fuel and coal coked as estimated by producer at average prices that might have been received if such coal had been sold commercially.)

[2] Production of Montrose, Pitkin, and Rio Blanco Counties combined with El Paso County to avoid disclosing individual company confidential data.

[3] Production of Moffat, Montrose, and Pitkin Counties combined with El Paso County to avoid disclosing individual company confidential data.

Natural Gas.—Dry natural gas was produced at fields in La Plata, Mesa, Garfield, and Baca Counties. Residual gas from 13 plants processing oil-well gas from 13 counties was marketed through pipelines. Production of oil-well gas was principally from fields in Rio Blanco County, followed by Moffat, Morgan, Logan, Weld, and Washington Counties. Reports [3] by the Colorado Oil and Gas Conservation Commission showed the total production of dry natural gas at 66 billion cubic feet and oil-well gas at 68.3 billion cubic feet. Total plant intake was 82.4 billion cubic feet, including some dry natural gas that was passed through plants without processing. Two plants in Moffat County, not included in the total, processed dry natural gas to remove moisture and improve the quality of the gas.

The bulk of the residual gas from the Rangely plant in Rio Blanco County was used for repressuring the Weber pool at the Rangely field. Injection was at the rate of approximately 3.7 billion cubic feet per month.

Northwest of Denver, Public Service Co. of Colorado (PSC) continued to improve its facility at the abandoned Leyden coal mine for storing natural gas during the summer. During subzero periods, as much as 95 million cubic feet per day was withdrawn. Total capacity of the facility was approximately 3 billion cubic feet, although the maximum stored at any one time had not exceeded 1.5 billion cubic feet.

Natural Gas Liquids.—Natural gasoline, butane, and propane were recovered at 13 plants that processed oil-well gas. One new plant, at the McClave field in Kiowa County, was operated from July through October. In December, Continental Oil Co. completed building a 20-

[3] The Oil and Gas Conservation Commission of the State of Colorado. Colorado Oil and Gas Statistics for 1963. Pt. 1, Oil and Gas Production, 1963, 85 pp.; Pt. 3, Gasoline and Extraction Plants, 1963, 4 pp.

million-cubic-foot-per-day processing plant near Fruita in Mesa County. Gas for the plant was to come from fields in Garfield and Rio Blanco Counties. The Colorado Oil and Gas Conservation Commission reported [4] that from 82.4 billion cubic feet of gas processed, including some dry natural gas passed through plants without processing, 3.6 million barrels (151.7 million gallons) of natural gas liquids was recovered.

Oil Shale.—Oil-shale deposits in Colorado, Utah, and Wyoming received considerable attention throughout the year. Four proposals had been received early in 1963, following approval of HR 5423 in October 1962, authorizing the U.S. Department of the Interior to make arrangements with public or private groups or persons to use the Federal Bureau of Mines facilities at Rifle for research. The proposals were submitted by the Colorado School of Mines Research Foundation, Inc., Golden; Garrett Research and Development Co., Pomona, Calif.; Socony-Mobil Oil Co., Inc., New York, N.Y.; and the University of Colorado, Boulder. Near the end of the year unofficial agreement was reached with the Colorado School of Mines Research Foundation, Inc., but further negotiation continued. The proposal provided for leasing the facilities for 5 years to the Foundation for research. The Foundation, in turn, was to contract for technical services from private industry—Socony-Mobil Oil Co. and Humble Oil Co. which with other companies would finance the research program.

A number of oil companies requested long-term leases of extensive tracts of oil-shale land for conducting other research activities including in situ extraction of shale oil by fire-flood techniques. These proposals were being considered at the end of the year. Other companies planning to build commercial oil-shale plants in Western Colorado proposed using oil shale from privately owned deposits. The announcements anticipated commercial production of shale oil in 5 to 10 years.

The Laramie Petroleum Research Center continued study of oil shales and published reports [5] of the investigation.

Peat.—Output of peat from deposits in four counties increased 12 percent in quantity and 44 percent in value over that of 1962. The use of peat as a soil conditioner and vehicle for organic fertilizers steadily increased. The material was dried, sized, and marketed, either in bulk or package. Part of the dried peat was mixed with certain organic fertilizers to increase its effectiveness. The products were particularly effective in improving many of the clayey, semi-alkali soils prevalent in many of the Mountain and Southwestern States.

Petroleum.—Petroleum production from 2,030 wells in 355 fields in 19 counties declined 4.2 million barrels, or 10 percent below that of 1962. Declining output from older fields and the lack of new discoveries and extensions had accounted for the drop. Production from the Weber pool at the Rangely field in Rio Blanco County, 1 percent below that of 1962, was 40 percent of the State total. Secondary-recovery operations at the field continued as planned; production was

[4] The Oil and Gas Conservation Commission of the State of Colorado. Colorado Oil and Gas Statistics for 1963. Pt. 3, Gasoline and Extraction Plants, 1963, 4 pp.

[5] Robinson, W. E., D. L. Lawler, J. J. Cummins, and J. I. Fester. Oxidation of Colorado Oil Shale. BuMines Rept. of Inv. 6166, 1963, 33 pp.

Smith, J. W., L. G. Trudell, and K. E. Stanfield. Comparison of Oil Yields From Core and Drill-Cutting Sampling of Green River Oil Shales. BuMines Rept. of Inv. 6299, 1963, 35 pp.

Tisot, P. R., and W. I. R. Murphy. Physical Structure of Green River Oil Shale From Colorado. BuMines Rept. of Inv. 6184, 1963, 24 pp.

virtually stabilized. Output at the Adena field in Morgan County, the second largest producing field in the State, declined 45 percent compared with that of 1962.

TABLE 8.—Crude petroleum production, by counties [1]

(Thousand barrels)

County	1962	1963 [2]	Principal fields in 1963 in order of production
Adams	608	478	Badger Creek, Middlemist, Beacon, Deer Trail, Windy Hill.
Archuleta	80	79	Price Gramps.
Baca	205	262	Flank.
Bent	1	2	McClave, Bent's Fort.
Boulder	3	2	Boulder.
Fremont	29	26	Florence-Canon City.
Jackson	551	463	McCallum, Battleship.
Kiowa	14	11	Brandon.
La Plata	57	58	Red Mesa.
Larimer	184	274	Loveland, Fort Collins, Wellington.
Logan	4,612	4,197	Northwest Graylin, Lewis Creek, East Atwood, Yenter, West Padroni, Cliff, Minto.
Moffat	995	1,296	Williams Fork, Moffat, Iles, Danforth Hills.
Montezuma	232	367	Flodine Park.
Morgan	5,529	3,394	Adena, Sand River, Zorichak, Bijou.
Rio Blanco	18,531	18,308	Rangely, Wilson Creek.
Routt	132	93	North Sage Creek, Tow Creek.
San Miguel	----------	2	Southeast Lisbon.
Washington	8,981	7,169	Plum Bush Creek, Big Beaver, Bison, Little Beaver, Blade, Bobcat.
Weld	1,732	1,790	Black Hollow, Pierce, Southwest Roggen, Mustang.
Yuma	1	----------	
Total	42,477	38,271	

[1] Based on Colorado Oil and Gas Conservation Commission county data adjusted to Bureau of Mines total.
[2] Preliminary figures.

TABLE 9.—Wildcat- and development-well completions in 1963, by counties

County	Oil	Gas	Dry	Total	Footage	County	Oil	Gas	Dry	Total	Footage
Wildcat:						Wildcat—Continued					
Adams	----	----	8	8	39,100	Weld	1	----	18	19	130,500
Arapahoe	----	----	4	4	22,400	Yuma	----	----	8	8	32,700
Archuleta	----	----	2	2	4,300	Total	13	12	262	287	1,433,100
Baca	----	2	13	15	75,400						
Bent	----	1	4	5	22,800	Development:					
Cheyenne	----	----	1	1	6,200	Adams	3	----	7	10	54,300
Costilla	----	----	1	1	3,200	Archuleta	----	5	1	6	42,500
Dolores	----	----	2	2	15,200	Baca	1	10	7	18	82,300
Elbert	----	----	1	1	5,600	Jackson	1	----	----	1	6,500
Garfield	----	----	4	4	10,900	Kiowa	----	----	1	1	4,100
Gunnison	----	----	1	1	3,700	La Plata	3	40	1	44	272,100
Jackson	----	----	3	3	18,500	Larimer	5	----	1	6	32,900
Kiowa	----	----	2	2	8,300	Las Animas	----	1	----	1	1,100
Larimer	----	----	6	6	32,100	Logan	10	----	18	28	148,800
Las Animas	----	----	2	2	4,000	Mesa	----	5	1	6	38,900
Lincoln	----	----	1	1	4,900	Moffat	8	2	7	17	83,200
Logan	3	1	35	39	196,900	Montezuma	2	----	4	6	30,000
Mesa	----	3	3	6	24,800	Morgan	9	6	22	[1] 39	216,400
Moffat	1	1	7	9	58,000	Rio Blanco	7	10	18	35	109,500
Montezuma	----	----	16	16	33,800	Routt	1	----	2	3	11,300
Montrose	----	----	5	5	43,300	Sedgwick	----	1	----	1	3,300
Morgan	4	3	16	23	125,100	Washington	20	----	36	56	276,600
Otero	----	----	1	1	2,000	Weld	13	1	21	35	218,700
Ouray	----	----	1	1	5,500	Total	83	81	147	[1] 313	1,632,500
Prowers	----	----	2	2	11,200						
Rio Blanco	----	1	7	8	24,800	Total all drilling	96	93	409	[1] 600	3,065,600
San Miguel	----	----	1	1	9,700						
Washington	4	----	87	91	458,200						

[1] Includes 2 service wells.

Source: Oil and Gas Journal.

TABLE 10.—Oil and gas discoveries in 1963

County and field	Well	Operator	Location			Producing formation	Gross producing interval (feet)	Total depth (feet)	Initial production		Total Date of completion	Remarks
			Section	Township	Range				Barrels oil per day	Thousand cubic feet of gas per day		
Baca County:												
Unnamed	No. 1-5 Cook	Horizon Oil & Gas Co.	5	33 S	43 W	Topeka	3,170–3,180	5,100	-----	2,060	Dec. 2	Flowed. New field.
Do	No. 1-2 Holmes	Davis Drilling Co.	2	34 S	42 W	Morrow	4,458–4,468	4,670	-----	1,350	May 2	Do.
Bent County: Caddoa	No. 1 Frankfort-Aikman Brothers-Government.	Frankfort Oil Co.	16	23 S	50 W	Atoka	4,678–4,696	5,130	-----	1,120	Dec. 18	Do.
Dolores County: Big Canyon.	No. 1 Big Canyon	Continental Oil Co.	17	41 N	18 W	Hermosa	4,429–4,562	9,515	-----	3,250	Dec. 27	Flowed from open hole. New field.
Logan County:												
Dune Ridge	No. 1 Government	Patrick A. Doheny	4	6 N	52 W	"D" Sandstone.	4,487–4,489	4,656	-----	1,055	Jan. 6	Flowed. Extension of Dune Ridge field.
Pawnee Creek	No. 1 Van Gundy	Maverick Oil Co.	2	7 N	54 W	"J" Sandstone.	4,941–4,947	4,993	100	-------	Sept. 12	Pumped. Extension of Pawnee Creek field.
Lodge	No. 1 Edens	Otto Yenter-Art Edens.	14	8 N	54 W	----do-------	5,101–5,114	-------	10	-------	July 12	Pumped. Old well work-over.
East Mount Hope	No. 1 Davis, et al	W. C. McBride, Inc.	29	9 N	53 W	"O" Sandstone.	5,259–5,272	5,315	55	-------	Oct. 18	Pumped. New producing horizon.
Mesa County:												
Unnamed	No. 1 El Pomar	Terry Oil Co.	28	8 S	97 W	Mesa Verde	519– 550	550	-----	325	Oct. 18	Flowed. New field.
Dakota Discovery	No. 1-31 Government	United Producing Co.	31	8 S	98 W	Dakota	7,200–7,222	7,842	-----	1,750	Apr. 19	Do.
Do	No 1 Roberts Canyon	Texaco Inc.	5	10 S	97 W	----do-------	6,729–6,842	7,518	-----	5,200	Oct. 27	Do.
Moffat County:												
Moffat	No. 13 Walter Wick	Texaco Inc.	10	4 N	91 W	Minturn	7,038–7,102	10,758	33	-------	Sept. 21	Pumped. New producing horizon.
Williams Fork	No 4 Helmke-Government.	----do-------	18	5 N	91 W	Shinarump	7,571–7,610	7,658	250	-------	July 12	Do.
Danforth Hills	No. 1 Doll	----do-------	13	5 N	96 W	Dakota	4,630–4,632	5,285	3	-------	Mar. 8	Do.
Hiawatha	No. 20 Wilson	Mountain Fuel Supply Co.	15	12 N	100 W	Mesa Verde	8,368–8,436	8,495	-----	517	Oct. 10	Flowed. New producing horizon.

Morgan County:												
North Pinneo	No. 1 Bass	Chandler & Simpson, et al.	3	2 N	55 W	"D" Sandstone.	5,042–5,046	5,159		4,500	Feb. 11	Flowed. New field.
Rawhide	No. 1 Painter	Patrick A. Doheny	34	2 N	55 W	do	4,877–4,879	5,026	63		Jan. 4	Pumped. New field.
Lamborn Draw	No. 2 McClarnan	Kimbark Exploration	23	5 N	59 W	do	6,039–6,041	6,095	72		June 3	Do.
Maple	No. 1 Barer-Rocchio	Raymond Oil Co	19	5 N	60 W	do	6,474–6,484	6,580	60	2,711	Feb. 15	Flowed. New field.
Unnamed	No. 1 Wulf	Morwell Oil Co	6	6 N	58 W	do	6,406–6,410		7	300	May 1	Pumped. Old well work-over.
Plainsman	No. 1 McCourt	J. G. Dyer	5	6 N	60 W	do	6,721–6,726	6,793	146		May 4	Pumped. New field.
Rio Blanco County: South Douglas Creek.	No. 1-B Government	Cities Service Oil Co	1	4 S	102 W	Morapos	1,101-1,260	1,260		672	May 1	Flowed from open hole. New field.
Washington County:												
Jitter	No. 1 Sharp	Bander & Couch	1	1 S	54 W	"D" Sandstone.	4,813–4,820	4,921	279		June 23	Pumped. New field.
Ranger	No. 1 Davis	Union-Texas Petroleum Division, Allied Chemical Corp.	30	3 S	51 W	"J" Sandstone.	4,163–4,169	4,395	171		Nov. 6	Do.
Barefoot	No. 1 Anderson	Bander & Couch	19	3 S	52 W	do	4,453–4,456	4,481	174		Sept. 6	Do.
Ranchero	No. 1 Fassler	Patrick A. Doheny	32	2 N	53 W	do	4,790–4,797	4,900	250		June 21	Do.
Pinto	No. 1 Theurer	Union-Texas Petroleum Division, Allied Chemical Corp.	28	3 N	52 W	"D" Sandstone.	4,680–4,689	4,850	14	163	July 18	Do.
Weld County: Bounty	No. 1 State	Stuarco Oil Co	36	8 N	57 W	"J" Sandstone.	6,054–6,057	6,130	99		Apr. 19	Do.

Exploratory and development drilling was below that of 1962, with 600 wells (287 exploratory, 313 development) completed compared with 758 wells (382 exploratory, 376 development) completed in 1962. There were 13 oil and 12 gas discoveries compared with 18 oil and 14 gas discoveries in 1962.

Wildcat drilling in eastern Colorado, including some exploration of deeper formations, was confined mostly to the cretaceous formations that had been productive. There was considerable activity south and east of the Las Animas Arch in the southeastern counties where three new gasfields were discovered. The attempt to find oil in the deeper Mississippian formation at the Florence field, second oldest in the Nation, was a failure. Exploration in western Colorado was distributed throughout the area, with discoveries in the northwestern counties. The deepest exploratory well in Colorado, drilled in Montrose County, was a failure. The well, planned to reach Mississippian formations, did not penetrate the objective and was abandoned at 18,354 feet.

Four refineries in the Denver metropolitan area were operated the entire year; the fifth, Skelly Oil Co., closed its 1,700-barrel-per-day refinery in October and transferred all refining activities to its refinery at El Dorado, Kans. Other refineries were operated at Alamosa and at Rangely. Total throughput was 13.2 million barrels, a drop of 1.6 percent below that of 1962. Ten percent (1.3 million barrels) of the throughput was from Colorado fields, representing 3 percent of the State production. Most of the crude oil refined in the seven refineries was from Wyoming, 79 percent; from Montana, 8 percent; and smaller amounts from Canada, Nebraska, and New Mexico. Shipments of crude oil from Colorado were to refineries in Illinois, Indiana, Kansas, Ohio, and Utah; and smaller amounts to Michigan, Oklahoma, Pennsylvania, and Wyoming.

METALS

Beryllium.—Beryllium-concentrate production from five mines in three counties was 4 percent below that of 1962, although the value dropped 24 percent. Major production was at the Boomer mine in Park County by U.S. Beryllium Corp. The output, containing beryl and bertrandite which averaged 3-percent beryllium oxide, was shipped to Mineral Concentrates and Chemical Co., Inc., (Mincon) for upgrading at its concentrator on Badger Flats near Lake George. Mincon also processed a small quantity of flotation concentrate at Loveland, where high-purity beryllium compounds were produced.

The remainder of the output, hand-sorted beryl containing an average of 11.7-percent beryllium oxide, was processed by Beryl Ores Co. at Arvada for the production of beryllium compounds.

Cadmium and Thallium.—American Smelting and Refining Co. (Asarco) recovered cadmium and thallium metal and thallium sulfate at its Globe plant in Denver; the compounds were recovered from flue dust, dross, and other byproduct materials from company and other smelters and processing plants.

Gold, Silver, Copper, Lead, and Zinc.—Gold, silver, copper, lead, and zinc production was almost entirely from mines whose principal product was copper, copper-lead-zinc, and lead-zinc ores. Production of these metals, as a group, was recorded from 20 counties; however, 9 mines in 9 counties accounted for 90 percent of the gold, 96 percent of the silver, 97 percent of the copper, 98 percent of the lead, and 99 percent of the zinc.

TABLE 11.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1954–58 (average)	115	17	1,003	89,972	$3,149	2,664	$2,411
1959	65	16	769	61,097	2,138	1,341	1,213
1960	70	15	809	61,269	2,144	1,659	1,502
1961	57	19	938	67,515	2,363	1,965	1,817
1962	25	16	872	48,882	1,711	2,088	2,265
1963	47	19	975	33,605	1,176	2,307	2,951
1858–1963	[3]	[3]	[3]	40,696,573	918,257	772,861	607,252

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	4,476	$2,955	17,720	$5,027	38,976	$9,159	$22,701
1959	2,940	1,805	12,907	2,969	35,388	8,139	16,264
1960	3,247	2,085	18,080	4,231	31,278	8,070	18,032
1961	4,141	2,485	17,755	3,658	42,647	9,809	20,132
1962	4,534	2,793	17,411	3,204	43,351	9,971	19,944
1963	4,169	2,568	19,918	4,302	48,109	11,065	22,062
1858–1963	311,875	101,935	2,816,407	338,453	2,058,963	388,969	2,354,866

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes re-treated, and ore, old slag, or tailings shipped to smelters during the calendar year indicated.
[2] Does not include gravel washed.
[3] Data not available.

TABLE 12.—Mine production of gold, silver, copper, lead, and zinc in 1963, by counties, in terms of recoverable metals

County	Mines producing [1]		Material sold or treated [2] (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
Adams		4		989	$34,615	136	$173
Boulder	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Clear Creek	7	1	6,337	44	1,540	248,140	317,401
Dolores	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Eagle	1		294,271	4,861	170,135	632,438	808,964
Gilpin	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Gunnison	4		34,373	81	2,835	210,371	269,090
Hinsdale	4		60	9	315	492	629
Jefferson		5		492	17,220	79	101
Lake			2,345	610	21,350	17,294	22,121
Mineral	1		26,039	440	15,400	252,555	323,048
Montrose		2		2	70		
Ouray	4		182,450	10,154	355,390	313,453	400,944
Park	4	2	317	20	700	5,352	6,846
Pitkin	1		3			9	12
Pueblo			90	2	70	406	519
Saguache	1		53			182	233
San Juan	4		134,971	1,249	43,715	127,497	163,084
San Miguel	[3] 9	[3] 5	[3] 275,393	[3] 14,415	[3] 504,525	[3] 469,838	[3] 600,980
Summit	6		18,336	237	8,295	29,063	37,175
Total:							
1963	46	19	975,038	33,605	1,176,175	2,307,305	2,951,320
1962	25	16	871,725	48,882	1,710,870	2,087,813	2,265,277

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Adams							$34,788
Boulder	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Clear Creek	6	$4,004	110	$23,641	125	$28,738	375,324
Dolores	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Eagle	656	404,035	3,352	724,032	25,264	5,810,651	7,917,817
Gilpin	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Gunnison	247	152,491	882	190,534	1,687	387,964	1,002,914
Hinsdale	1	431	1	281	(4)	12	1,668
Jefferson							17,321
Lake	17	10,441	142	30,618	95	21,930	106,460
Mineral	141	86,794	1,205	260,258	1,644	378,074	1,063,574
Montrose							70
Ouray	1,141	702,548	4,043	873,375	5,499	1,264,713	3,596,970
Park	1	801	42	8,964	8	1,771	19,082
Pitkin			(4)	54	(4)	46	112
Pueblo	1	400	5	756	34	7,912	9,657
Saguache	(4)	154	1	313	3	678	1,378
San Juan	264	162,470	2,939	634,900	4,094	941,586	1,945,755
San Miguel	[3] 1,683	[3] 1,036,944	[3] 6,433	[3] 1,389,657	[3] 8,661	[3] 1,992,076	[3] 5,524,182
Summit	11	6,591	764	164,905	995	228,919	445,885
Total:							
1963	4,169	2,568,104	19,918	4,302,288	48,109	11,065,070	22,062,957
1962	4,534	2,792,944	17,411	3,203,624	43,351	9,970,730	19,943,445

[1] Operations at slag dumps and old mill or miscellaneous cleanups not counted as producing mines.
[2] Does not include gravel washed.
[3] Production of Boulder, Dolores, Gilpin, and San Miguel Counties combined to avoid disclosing individual company confidential data.
[4] Less than 0.5 ton.

TABLE 13.—Mine production of gold, silver, copper, lead, and zinc in 1963, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines[1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold	3	312	274	1,814			
Dry gold-silver	3	254	113	1,972	400		5,100
Dry silver	12	5,387	14	248,625	14,100	175,500	198,000
Total	18	5,953	401	252,411	14,500	175,500	203,100
Copper	4	20,900	4,166	423,751	1,190,000	163,700	100
Copper-lead	1	3		118	300	800	
Copper-lead-zinc	5	501,069	24,619	967,027	6,219,300	22,086,700	31,041,200
Lead	8	453	18	13,281	7,800	167,300	22,400
Lead-zinc and zinc[2]	12	444,202	2,223	632,131	869,200	16,946,200	64,690,600
Total	28	966,627	31,026	2,036,308	8,286,600	39,364,700	95,754,300
Other "lode" material:							
Gold mill cleanup	(3)	40	9	4			
Copper mill cleanup	(3)	8	4	181	1,200		
Lead mill cleanup	(3)	6	10	94	200	1,400	
Lead smelter cleanup	(3)	1,350	194	13,727	26,800	181,200	50,000
Lead-zinc mill cleanup	(3)	227	400	2,377	2,100	66,300	23,900
Zinc cleanup, mill cleanup, and smelter cleanup	(3)	827	22	1,978	6,600	46,900	186,700
Total		2,458	639	18,361	36,900	295,800	260,600
Total "lode" material	46	975,038	32,066	2,307,080	8,338,000	39,836,000	96,218,000
Placer	19		1,539	225			
Total all sources	65	975,038	33,605	2,307,305	8,338,000	39,836,000	96,218,000

[1] Detail will not necessarily add to totals because some mines produce more than one class of material.
[2] Combined to avoid disclosing individual company confidential data.
[3] From properties not classed as mines.

TABLE 14.—Mine production of gold, silver, copper, lead, and zinc in 1963, by types of material processed and methods of recovery, in terms of recoverable metals

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Amalgamation:					
Ore	7,034	2,396			
Cleanup	9	4			
Total	7,043	2,400			
Concentration, and smelting of concentrates: Ore	20,098	1,662,410	7,231,000	39,074,100	95,797,900
Direct-smelting:					
Ore	4,295	623,913	1,070,100	466,100	159,500
Cleanup	630	18,357	36,900	295,800	260,600
Total	4,925	642,270	1,107,000	761,900	420,100
Placer	1,539	225			
Grand total	33,605	2,307,305	8,338,000	39,836,000	96,218,000

Major operations were Idarado Mining Co. at the Idarado mine in Ouray and San Miguel Counties; The New Jersey Zinc Co. at the Eagle mine at Gilman in Eagle County; Standard Metals Corp. at the Silver Lake and Sunnyside-Belle Creole mines in San Juan County; Emperius Mining Co. at the Emperius mine at Creede in Mineral

County; McFarland & Hullinger at the Keystone mine in Gunnison County; Humphreys Engineering Co. at the Cascade mine in Clear Creek County; Wellington Mine Association at the Wellington mine in Summit County; and Rico Argentine Mining Co. at the Rico Argentine mine in Dolores County. Gold was from 35 lode mines and 19 placer mines in 16 counties. At nine of the placer operations the gold was recovered as a byproduct of sand and gravel preparation in Adams County (four) and Jefferson County (five). A small quantity of silver was also recovered at these operations. Silver production from 46 lode mines in 15 counties increased 11 percent in quantity and 30 percent in value over that of 1962. The price of silver averaged $1.28 per ounce compared with $1.09 per ounce in 1962, thus accounting for the rise in value. The increased price generated considerable interest in silver production. Reopening the Keystone mine in Gunnison County by McFarland & Hullinger resulted in a substantial production of silver. Other mines that had been idled throughout the metal mining areas were examined; exploration and rehabilitation work was begun at some. No significant production resulted from these operations during the year.

Copper output from 30 mines in 12 counties declined 8 percent compared with that of 1962. The price of copper remained stable at 30.8 cents per pound throughout the year. Because of higher prices, greater emphasis on production of silver-lead-zinc resulted in a lesser output of copper-bearing ores.

Lead output was from 33 mines in 14 counties; zinc was produced at 26 mines in 14 counties. Lead and zinc production, from complex silver-copper-lead-zinc deposits, increased 14 and 11 percent in quantity and 34 and 11 percent in value, respectively, compared with that of 1962. The price of lead increased from $0.092 per pound in 1962 to $0.108 per pound in 1963; with the increased price of silver, mining such ores was made profitable. The price of zinc remained stable at $0.115 per pound.

Given considerable attention was the possibility of building a smelter to process complex gold, silver, copper, lead, and zinc ores from Colorado mines. The Colorado State Metal Mining Fund authorized the Colorado School of Mines Research Foundation, Inc., to make a preliminary investigation of the feasibility of using the process developed by Imperial Smelting Processes, Ltd., of England, for Colorado ores. The report of the investigation indicated that the establishment of such a smelter appeared to be technically and economically feasible, and the Area Redevelopment Administration, upon the request of officials of Clear Creek, Gilpin, and San Juan Counties, approved a technical-assistance grant to make a complete and comprehensive study of the economic and technical problems involved in constructing and operating an "Imperial" smelter. The study was to be completed by mid–1964.

Iron Ore.—Brown iron ore produced in San Miguel County was used for manufacturing paint pigments. A small quantity of limonite mined in prior years in San Miguel County was sold for use as a soil additive. The quantity sold was 64 percent below that of 1962. General Chemical Division, Allied Chemical Corp., recovered agglomerate (sinter) as a byproduct in manufacturing sulfuric acid from pyrites at its plant in Denver. The sintered agglomerate was used in manufacturing cement and for pig iron.

Molybdenum.—Production of molybdenum by Climax Molybdenum Co., Climax Division, American Metal Climax, Inc., at its Climax mine in Lake County was 47.4 million pounds recovered from 12.8 million tons of ore, a 45-percent gain over that of 1962. The mine was operated on a 3-shift, 7-day-week basis following settlement of a strike that began on July 18, 1962. Operations, resumed on January 9, were continuous throughout the year. Maximum output was rapidly achieved, but 1963 production did not reach the level of the prestrike years of 1960 and 1961.

Because of a high output of steel in 1963, the demand for molybdenum increased. Consumption of molybdenum in western Europe and Japan also increased significantly over that of 1962. The company obtained 2.4 million pounds of molybdenum from the National Stockpile, which was part of the 5 million pounds released by the Congress in June of 1962. Total sales were in excess of 50.6 million pounds.

Late in 1963 Climax Molybdenum Co. purchased the Urad molybdenum mine in Clear Creek County from Vanadium Corporation of America (VCA). The Urad mine had been idle since World War II when it was operated on a limited basis. The purchase followed a drilling and evaluation program during 1961–63. Development drilling was begun and production plans were prepared.

Tin and Tungsten.—Tin and tungsten were recovered as byproducts from the flotation tailing by Climax Molybdenum Co. at its Climax mine. The tungsten concentrate was upgraded and the final product, containing in excess of 70 percent tungstic oxide, was used in eastern States for the preparation of tungsten alloys. The low-grade tungsten rejects and the primary tin concentrate, containing 12 percent tin, were sold to Fred H. Lenway & Co., San Francisco, for upgrading to marketable products at the Marion mill in Boulder County and resale to consumers.

Uranium Ore.—Production of uranium ore from 336 operations in 13 counties dropped 11 percent compared with that of 1962. Major production continued to be from Montrose County, followed by Moffat, San Miguel, and Mesa Counties. Following the announcement by the AEC in November 1962 of the stretchout program, which provided for purchasing recovered uranium oxide concentrate through 1970, operators revised production schedules in anticipation of participating in the program. Proposals to participate in the program were made by all Colorado mills except that of the Cotter Corp. at Canon City. AEC was evaluating the proposals before negotiating extension of the current contracts. None had been approved at yearend. Although not specifically affected by the program, operations at some of the smaller mines ceased because of the exhaustion of reserves.

TABLE 15.—Mine production of uranium ore, by countries [1]

County	1962				1963			
	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]
Boulder	2	772	6,760	$29,788	2	(3)	(3)	(3)
Fremont	12	7,191	48,895	207,698	4	1,740	9,946	$41,556
Grand					1	(3)	(3)	(3)
Huerfano	1	(3)	(3)	(3)	1	321	817	2,170
Jefferson	5	16,766	225,260	1,034,009	5	15,300	215,566	1,001,299
Mesa	50	94,139	529,863	2,228,062	46	92,631	530,786	2,242,562
Moffat	30	(3)	(3)	(3)	31	(3)	(3)	(3)
Montezuma					1	(3)	(3)	(3)
Montrose	198	513,148	2,444,778	9,924,790	174	376,042	1,773,821	7,125,658
Park	1	95	341	1,231	2	(3)	(3)	(3)
Pueblo	1	(3)	(3)	(3)				
Rio Blanco	3	(3)	(3)	(3)	2	(3)	(3)	(3)
Saguache	5	(3)	(3)	(3)	1	17,686	265,096	1,221,554
San Miguel	72	136,697	643,272	2,615,036	66	125,513	604,374	2,489,854
Undistributed		366,632	806,216	2,003,254		384,973	784,570	1,739,784
Total	380	1,135,440	4,705,385	18,043,868	336	1,014,206	4,184,976	15,864,437

[1] Receipts at mills based on data supplied to the Bureau of Mines by AEC.
[2] F.o.b. mine value; base price, grade premiums, and exploration allowances. Calculated according to AEC Circular 5, Revised, price schedule.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

VCA purchased the Kerr-McGee Oil Industries, Inc., Navajo processing plant at Shiprock, N. Mex., and transferred its milling operation to the newly acquired plant on March 1. The VCA concentrating plant at Naturita was placed on standby in anticipation of future processing of vanadium ores at its properties in San Miguel County. The uranium processing plant at Durango was being dismantled; stockpiled ores, plant residues, and other uranium-bearing material at the plant were being processed at the Shiprock plant.

Uranium processing mills of Union Carbide Nuclear Co. at Rifle in Garfield County, at Uravan in Montrose County, and at Maybell in Moffat County; Climax Uranium Co. at Grand Junction in Mesa County; and Cotter Corp. at Canon City in Fremont County were operated at a reduced rate of throughput the entire year.

Uranium oxide shipped from Colorado mills was 4.3 million pounds valued at $34.1 million. Uranium oxide recovered from ores of Colorado origin was 3.9 million pounds valued at $31.6 million.

Vanadium.—Fused vanadium oxide was recovered at four Colorado uranium processing mills from uranium ores containing a significant quantity of vanadium oxide. The quantity recovered from Colorado ores was 19 percent below that of 1962, paralleling the decline in uranium-ore output. The major source of vanadium oxide was Montrose County, followed by San Miguel and Mesa Counties.

NONMETALS

Cement.—Production of portland and masonry cements by Ideal Cement Co., at its Portland plant in Fremont County and at its Boettcher plant at LaPorte in Larimer County, was 3 and 15 percent, respectively, below that of 1962. The Portland plant used portland cement clinker as a base for manufacturing masonry cement. None was produced at the Boettcher plant. Most of the output was used in Colo-

rado; shipments were made to consumers in Kansas, Nebraska, Nevada, New Mexico, Ohio, Oklahoma, Tennessee, Utah, and Wyoming.

Clays.—Production of bentonite, fire clay, miscellaneous clay, and shale was 14 percent in quantity and 15 percent in value below that of 1962. Output of fire clay was from seven counties in 1963; 17 percent was used for refractory products—fire brick, mortar, crucibles, and in foundries—and 83 percent for building brick, sewer pipe, and other heavy clay products. Of the total output of miscellaneous clay and shale produced from seven counties, 37 percent was used for building brick, sewer pipe, and heavy clay products and 63 percent was used for manufacturing lightweight aggregates. Combined uses of the fire clay and miscellaneous clay and shale were refractories 5 percent, building materials 50 percent, and lightweight aggregates 45 percent. Bentonite produced in Fremont County was used for lining irrigation canals and stock ponds to prevent water seepage.

TABLE 16.—Clay production, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Arapahoe	400	$600		
Boulder	27,496	61,124	(1)	(1)
Custer	492	1,673		
Douglas	92,818	236,669	85,097	$226,612
Elbert	(1)	(1)	(1)	(1)
El Paso	13,554	48,825	16,262	61,194
Fremont	25,103	100,653	32,189	132,565
Huerfano	(1)	(1)	(1)	(1)
Jefferson	554,009	832,361	468,759	664,776
Las Animas	21,947	45,480	16,082	29,121
Mesa	(1)	(1)		
Pueblo	47,104	171,611	44,905	166,281
Undistributed	18,951	73,724	22,842	53,347
Total	801,874	1,572,720	686,136	1,333,896

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Feldspar.—Output of feldspar from mines in Chaffee and Fremont Counties declined 73 percent compared with that of 1962. Equipment and buildings of the Western Feldspar Milling Co., the only feldspar grinding plant in the State, were sold at auction in November. Western Feldspar Milling Co. had been in operation for over 30 years. Output of the plant during 1963 was marketed in Oklahoma for manufacturing glass. Markets for feldspar from the Western States declined seriously because of the consolidation of larger companies based in the Eastern States which made competition more difficult for the smaller operators.

Fluorspar.—Production of fluorspar from mines in Boulder and Jackson Counties was 73 percent below that of 1962. General Chemical drastically curtailed the output of its Burlington mine at Jamestown and operation of its flotation plant at Valmont in Boulder County. Small crews were retained to provide company requirements for manufacturing hydrofluoric acid.

Gem Stones.—A great variety of mineral crystals, agate, petrified wood, mineral specimens, gem stones, and gem material was collected in 34 counties by individuals, mineralogical societies, and gem dealers. The value of the material was 40 percent above that of 1962.

Gypsum.—Gypsum production from mines in Fremont and Larimer Counties was 98,596 tons, 8 percent below that of 1962. One-half of the output was calcined and used for manufacturing wallboard lath and other building products. Crude gypsum was sold for use as a retarder in manufacturing portland cement and as a soil conditioner.

Lime.—Lime production at 15 plants in 13 counties was 127,643 tons, a 38-percent gain. Twelve plants were operated by sugar companies for manufacturing quicklime used in refining sugar. The Colorado Fuel and Iron Corp. (CF&I) produced quicklime for use in its steel plant at Pueblo; two plants produced hydrated lime for building products and for chemical and industrial uses.

Mica.—Scrap mica produced by Jolex Mica Co., Inc., at its Langston mine in Larimer County was ground at its plant in Ft. Collins: output was 440 tons, a twofold gain over that of 1962. The ground product was used for roofing and for oil-well drilling.

Perlite.—Crude-perlite production from mines in Custer and Fremont Counties was 37 percent below that of 1962. The output from Custer County was expanded at a plant in Fremont County for use in building plaster; for insulation and fireproofing material; as a filter aid, lightweight aggregate, and soil conditioning agent; and as filler and fire base. Crude perlite from deposits in New Mexico was processed at plants in Conejos and Denver Counties.

Pumice and Pumicite.—Pumice, volcanic cinders, and scoria mined in Costilla, Eagle, and Routt Counties was 21 percent below that of 1962. Crushed and sized, the material was used as a concrete aggregate, for road ballast, as roofing granules, and in rock gardens.

Pyrites.—Pyrites were produced by Rico Argentine Mining Co. in Dolores County for manufacturing sulfuric acid at its plant at the mine. The acid was used in processing uranium ores at plants in Colorado and New Mexico. Pyrites were recovered as a byproduct by Climax Molybdenum Co. in the concentration of molybdenum ore. The pyrites were used by General Chemical for manufacturing sulfuric acid at its plant at Denver.

Salt.—Salt was produced by Union Carbide Nuclear Co. Division, Union Carbide Corp., from well brines in Montrose County. The salt was used in processing uranium ores at company-owned plants at Rifle and Uravan.

Sand and Gravel.—Sand and gravel production from pits in 60 counties was 6 percent above that of 1962. The high rate of building construction in centers of population and on highway construction throughout the State continued. Output was from 314 operations, 137 by commercial operators and 177 by Government crews and contractors. Production by Government crews and contractors represented 45 percent of the total; of that, 58 percent was for the State highway department, 33 percent for county governments, 6 percent for Federal agencies, and 3 percent for municipalities. Of the total production of 20.4 million tons, 13.7 million tons or 67 percent was used for highway construction and paving; 5.7 million tons or 28 percent for building construction; the remaining 1 million tons or 5 percent for fill, railroad ballast, and preparing blast sand, engine sand, and sand for fracturing formations in oil wells.

Building sand and gravel was priced at $1.22 per ton, and paving sand and gravel at $0.95 per ton. The average value of all sand and gravel produced was $1.03 per ton.

Major production was from Adams County, followed by Jefferson, Larimer, El Paso, Pueblo, and Arapahoe Counties, in that order, each having a total production in excess of 1 million tons.

TABLE 17.—Sand and gravel production in 1963, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Adams	3,178	$3,298	La Plata	185	$181
Alamosa	235	234	Larimer	1,337	1,612
Arapahoe	1,093	1,237	Las Animas	197	217
Archuleta	176	127	Lincoln	463	277
Baca	7	4	Logan	277	277
Bent	40	42	Mesa	833	867
Boulder	692	876	Mineral	5	4
Chaffee	95	104	Moffat	340	294
Cheyenne	11	6	Montezuma	108	143
Clear Creek	10	13	Montrose	124	85
Conejos	130	114	Morgan	687	766
Costilla	129	81	Otero	259	289
Crowley	5	4	Ouray	8	9
Custer	32	30	Park	230	178
Delta	[1] 609	[1] 703	Phillips	7	7
Denver	[1]	[1]	Pitkin	306	342
Dolores	120	77	Prowers	103	124
Douglas	526	576	Pueblo	1,257	1,217
Eagle	178	206	Rio Blanco	100	87
Elbert	267	229	Rio Grande	26	29
El Paso	1,291	1,124	Routt	161	231
Fremont	57	82	Saguache	89	87
Garfield	27	49	San Miguel	91	68
Grand	71	84	Sedgwick	84	74
Gunnison	386	457	Summit	151	156
Hinsdale	4	2	Teller	97	146
Huerfano	226	175	Washington	16	8
Jackson	70	58	Weld	800	702
Jefferson	1,988	2,090	Yuma	228	216
Kit Carson	82	73			
Lake	81	81	Total	20,385	20,929

[1] Delta and Denver Counties combined to avoid disclosing individual company confidential data.

TABLE 18.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	1,945	$2,150	2,247	$2,625
Paving	375	294	584	599
Fill	25	14	116	77
Railroad ballast			3	3
Other	16	13	(1)	(1)
Industrial:				
Blast	(2)	(2)	(2)	(2)
Engine	(2)	(2)	(2)	(2)
Filtration	(2)	(2)	(2)	(2)
Oil (hydrafrac)	(2)	(2)		
Other	32	126	46	103
Total	2,393	2,597	2,996	3,407
Gravel:				
Construction:				
Building	3,363	4,435	3,282	4,103
Paving	4,519	4,327	4,459	4,404
Railroad ballast	(1)	(1)	7	11
Fill	107	82	192	143
Other	84	165		
Miscellaneous	184	179	282	298
Total	8,257	9,188	8,222	8,959
Total sand and gravel	10,650	11,785	11,218	12,366
Government-and-contractor operations:				
Sand:				
Building	37	40	(3)	(4)
Paving	175	92	657	621
Fill	78	52	24	28
Total	290	184	681	649
Gravel:				
Building	227	198	203	239
Paving	7,861	6,550	7,974	7,433
Fill	285	209	309	242
Total	8,373	6,957	8,486	7,914
Total sand and gravel	8,663	7,141	9,167	8,563
All operations:				
Sand	2,683	2,781	3,677	4,056
Gravel	16,630	16,145	16,708	16,873
Total	19,313	18,926	20,385	20,929

[1] Figure withheld to avoid disclosing individual company data; included with "Fill."
[2] Figure withheld to avoid disclosing individual company data; included with "Other."
[3] Less than 500 short tons.
[4] Less than $500.

The Colorado Department of Highways awarded contracts for $42.6 million for constructing the National System of Interstate and Defense Highways, $23.8 million for Federal-aid projects (ABC program), $2 million for State highways, and expended $11.5 million in repairing and maintaining existing highways. Expenditures planned for 1964 were $65.7 million, or 4 percent below those of 1963. Reports [6] showed that during the year 62.8 miles of the National System of Interstate and Defense Highways had been completed to full standards and that 1.6 miles had been improved to standards adequate to current traffic.

[6] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1963. Press Release BPR 64–9, Feb. 7, 1964.

The total mileage of the system open to traffic was 368.1 miles; 61.4 miles was under construction, and engineering studies and acquisition of right-of-way were in progress on 254.2 miles, leaving 325.7 miles of the system in the State to be programed. Under the Federal-Aid Program for Primary and Secondary Highway Systems (ABC program), 221.4 miles was completed in 1963. Total completed mileage in the State of Federal-aid projects was 2,409.2 miles.

Major projects on the Interstate System were sections on Interstate Highway 25 that transverses the State from north to south and on Interstate Highway 70 that transverses the State from east to west. The two highways cross at Denver; because of the very dense traffic pattern in and adjacent to the city, the junction of the two highways require extensive interchange construction as well as elevated and other major approach projects. Progress on the Straight Creek Tunnel, on Interstate Highway 70 through the Continental Divide, continued.

Stone.—Production of various types of stone was 7 percent above that of 1962. Crushed stone of various types represented 99 percent of the output. Crushed limestone, 85 percent of the total stone production, was used for manufacturing cement and lime, as a flux in steelmaking, and as a concrete aggregate. Other uses included ground limestone for rock drilling in coal mines and as a mineral food. Crushed sandstone was used as a refractory stone, for concrete aggregate, and in precast concrete shape. Crushed and broken miscellaneous stone, second to limestone in output, was widely used by contractors for the State highway department for riprap and in road construction. Crushed basalt (traprock) was also used in road construction. Other types of crushed stone, marble, and granite were used for decorative purposes in specialty products such as cast articles of ground marble aggregates, terrazzo, roofing granules, and as an ornamental aggregate.

TABLE 19.—Stone production in 1963, by counties

County	Short tons	Value	County	Short tons	Value
Adams	560	$803	Larimer	864,896	$1,780,808
Arapahoe	224	493	Lincoln	614	1,535
Archuleta	8,752	15,149	Logan	1,783	2,053
Baca	3,035	6,677	Mesa	1,489	19,931
Boulder	37,340	151,796	Moffat	675	1,485
Chaffee	190,325	442,621	Montrose	89	196
Conejos	20	50	Morgan	2,421	5,509
Costilla	1,765	3,883	Otero	1,134	2,495
Douglas	59,789	121,092	Park	7,560	50,452
Eagle	7,254	17,249	Pueblo	11,338	26,780
Elbert	763	1,908	Routt	19,968	29,779
El Paso	(1)	(1)	Saguache	501	1,102
Fremont	820,046	1,750,279	Summit	19,624	41,371
Garfield	(1)	(1)	Teller	1,180	15,900
Grand	999	2,265	Washington	1,784	2,054
Gunnison	26,453	68,887	Weld	57,998	73,557
Jackson	138	304	Undistributed	322,241	892,833
Jefferson	21,154	133,195			
Kiowa	3,828	8,422	Total	2,509,677	5,693,165
La Plata	11,937	20,252			

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 20.—Stone sold or used by producers, by kinds

Year	Basalt and related rocks (traprock)		Granite		Limestone		Marble	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1959	(1)	(1)	136,439	$229,460	2,482,700	$4,344,000	(1)	(1)
1960	16,400	$25,700	145,944	532,041	2,123,194	3,484,757	4,075	$124,026
1961	-------	-------	10,528	145,988	2,221,902	4,255,761	9,350	75,171
1962	-------	-------	20,872	161,315	2,164,513	4,395,440	9,094	79,960
1963	72,915	83,173	73,580	199,984	2,139,431	4,170 148	8,749	64,063

Year	Sandstone		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1959	43,381	$294,015	161,149	$669,043	2,823,669	$5,536,518
1960	61,371	298,447	90,952	185,809	2,441,936	4,650,780
1961	52,281	427,356	157,229	396,288	2,451,290	5,300,564
1962	67,378	493,597	90,854	467,000	2,352,711	5,597,312
1963	107,731	635,054	107,271	540,743	2,509,677	5,693,165

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other stone."

TABLE 21.—Stone sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction and rubble, short tons	11,866	$121,302	11,950	$131,577
Rough architectural, cubic feet	[1] 81,203	88,747	[2] 67,852	63,868
Dressed architectural, do	[3] 31,234	63,121	[4] 177,072	124,197
Rough monumental, do	[5] 7,965	11,947	[6] 11,505	48,600
Dressed monumental, do	(7)	(7)	-------	-------
Flagging, do	[8] 31,652	31,311	[9] 18,190	19,759
Other, do	[10] 5,300	105,300	-------	-------
Total (approximate, in short tons)	24,430	421,728	28,729	388,001
Crushed and broken stone:				
Riprap, short tons	55,750	148,372	47,576	112,336
Metallurgical, do	317,131	677,076	292,185	644,198
Concrete and roadstone, do	302,072	774,390	470,038	1,119,467
Other, do	[11] 1,653,328	[11] 3,575,746	[12] 1,671,149	[12] 3,429,163
Total, do	2,328,281	5,175,584	2,480,948	5,305,164
Total stone (approximate, in short tons)	2,352,711	5,597,312	2,509,677	5,693,165

[1] Approximately 6,563 short tons.
[2] Approximately 5,581 short tons.
[3] Approximately 2,438 short tons.
[4] Approximately 8,819 short tons.
[5] Approximately 669 short tons.
[6] Approximately 965 short tons.
[7] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[8] Approximately 2,469 short tons.
[9] Approximately 1,414 short tons.
[10] Approximately 425 short tons.
[11] Includes stone used in cement, coal dust, erosion control, exposed aggregate, feed, filters, landscaping, lime, markers, ornamental aggregate, plastics, poultry grit, precasting, roofing granules, and terrazzo.
[12] Includes stone used in cement, coal dust, colored concrete, exposed aggregate, foundry, ground cover, landscaping, lime, mineral food, ornamental aggregate, precasting, roofing granules, terrazzo, and tumbling.

Dimension sandstone, mostly from quarries in Larimer County, was used extensively for public and private building construction. The pink to red quartzitic Lyons sandstone was used exclusively in constructing new buildings at the University of Colorado at Boulder. Some dimension marble was produced in Fremont County for building facings, and dimension granite was produced in Chaffee, Larimer, and Teller Counties for monumental purposes. Following an examination of the marble quarries at Marble in Gunnison County by the Vermont Marble Co., Proctor, Vt., owners of the quarry, an announcement was made that a program of diamond drilling to determine the extent of the deposit and condition of the marble at depth was to be started probably in 1965.

Vermiculite.—Vermiculite produced by Insuplast, Inc., at its mine near Westcliffe in Custer County, was exfoliated at its plant at Canon City in Fremont County. The processed material was used for insulation and for sound control. Western Mineral Products Co. processed crude vermiculite from deposits in Montana at its plant in Denver. The exfoliated product was used for loose-fill insulation, as an aggregate in plaster, and for acoustical purposes.

REVIEW BY COUNTIES

Only those counties with significant production or activity in the mineral industry are discussed; see table 22 for additional details.

Adams.—The county was ranked first in the State in sand and gravel production and seventh in output of crude petroleum. The combined value of these two commodities accounted for 96 percent of the total value of mineral production in the county in 1963. Sand and gravel was produced for building, paving, fill, and railroad ballast at 23 operations by 13 operators. Major producers were Brannan Sand & Gravel Co., Boise Cascade Sand & Gravel Co., Cooley Gravel Co., Western Paving Construction Co., and Hubner Construction Co. The output was used in a great variety of building projects in the Denver Metropolitan area. Contractors produced paving sand and gravel for the State highway department and the city of Denver. Government crews produced paving sand and gravel for the State highway department, the county highway department, and the city of Denver; the largest output in this category was by the city of Denver and county highway department.

Crude-petroleum output from 62 wells in 17 fields was 21 percent below that of 1962. Principal producing fields were Badger Creek, Middlemist, and Beacon. Output of oil-well gas from the Middlemist and Leader fields also declined; the natural gas processing plant at the Leader field remained closed.

747-416—64——17

TABLE 22.—Value of mineral production in Colorado, by countries

County	1962	1963 [1]	Minerals produced in 1963 in order of value
Adams	$5,649,310	$4,858,591	Sand and gravel, petroleum, natural gas, lime, gold, stone, silver.
Alamosa	113,900	234,000	Sand and gravel.
Arapahoe	1,886,740	1,237,493	Sand and gravel, stone.
Archuleta	274,917	370,149	Petroleum, sand and gravel, stone.
Baca	714,500	900,677	Petroleum, natural gas, stone, sand and gravel.
Bent	28,600	74,000	Sand and gravel, natural gas, petroleum.
Boulder	1,863,995	1,536,180	Sand and gravel, fluorspar, lime, stone, uranium ore, clays, peat, gold, petroleum, silver, gem stones, vanadium.
Chaffee	(2)	(2)	Stone, sand and gravel, feldspar, gem stones.
Cheyenne	73,900	6,000	Sand and gravel.
Clear Creek	101,671	388,346	Silver, zinc, lead, sand and gravel, copper, gold, gem stones.
Conejos	3,887	114,090	Sand and gravel, stone, gem stones.
Costilla	(2)	(2)	Sand and gravel, pumice, stone.
Crowley	36,250	(2)	Lime, sand and gravel.
Custer	(2)	(2)	Sand and gravel, perlite, vermiculite, gem stones.
Delta	(2)	586,388	Sand and gravel, coal, lime.
Denver	----------	(2)	Sand and gravel.
Dolores	(2)	(2)	Pyrites, lead, zinc, sand and gravel, silver, copper, gold, gem stones.
Douglas	830,251	924,509	Sand and gravel, clays, stone, gem stones.
Eagle	8,567,019	8,157,885	Zinc, silver, lead, copper, sand and gravel, gold, stone, pumice, gem stones.
Elbert	(2)	(2)	Sand and gravel, clays, stone, gem stones.
El Paso	1,337,287	1,784,425	Sand and gravel, stone, lime, clays, gem stones, coal, beryllium concentrate.
Fremont	11,909,516	11,333,755	Cement, stone, coal, gypsum, clays, sand and gravel, petroleum, uranium ore, perlite, feldspar, vanadium, gem stones, beryllium concentrate.
Garfield	907,032	669,312	Natural gas, stone, lime, coal, sand and gravel.
Gilpin	23,899	10,671	Peat, gold, zinc, silver, lead, copper.
Grand	52,981	(2)	Sand and gravel, stone, uranium ore, vanadium, gem stones.
Gunnison	1,524,348	2,459,372	Coal, sand and gravel, zinc, silver, lead, copper, stone, gold, gem stones.
Hinsdale	34,300	3,668	Sand and gravel, silver, copper, gold, lead, zinc.
Huerfano	440,797	464,010	Coal, sand and gravel, clays, uranium ore.
Jackson	1,662,350	1,423,304	Petroleum, sand and gravel, natural gas, stone.
Jefferson	4,582,910	3,907,197	Sand and gravel, uranium ore, clays, stone, gold, gem stones, silver.
Kiowa	227,306	223,447	Natural gas, petroleum, stone, natural gas liquids, gem stones.
Kit Carson	10,800	73,000	Sand and gravel.
Lake	46,940,156	68,144,480	Molybdenum, tungsten concentrate, pyrites, sand and gravel, tin, lead, silver, zinc, gold, copper, gem stones.
La Plata	[3] 5,977,200	6,222,918	Natural gas, natural gas liquids, sand and gravel, petroleum, coal, stone.
Larimer	13,723,583	14,008,932	Cement, stone, sand and gravel, petroleum, lime, gypsum, mica (scrap), gem stones.
Las Animas	6,768,234	7,628,389	Coal, sand and gravel, clays, carbon dioxide, gem stones.
Lincoln	89,000	278,535	Sand and gravel, stone.
Logan	[3] 15,600,246	14,240,106	Petroleum, natural gas, natural gas liquids, sand and gravel, lime, stone, gem stones.
Mesa	5,102,539	5,288,821	Uranium ore, vanadium, sand and gravel, coal, natural gas, stone, gem stones.
Mineral	1,393,881	1,067,909	Zinc, silver, lead, copper, gold, sand and gravel, gem stones.
Moffat	[3] 6,100,624	7,906,230	Petroleum, uranium ore, natural gas, coal, sand and gravel, stone, gem stones.
Montezuma	1,974,308	1,305,808	Petroleum, sand and gravel, natural gas, carbon dioxide, vanadium, uranium ore.
Montrose	19,096,286	13,809,337	Uranium ore, vanadium, coal, sand and gravel, salt, natural gas, stone, gold, gem stones.
Morgan	[3] 19,900,418	14,223,509	Petroleum, natural gas liquids, natural gas, sand and gravel, lime, stone.
Otero	(2)	(2)	Sand and gravel, lime, stone.
Ouray	3,814,123	3,606,850	Zinc, lead, copper, silver, gold, sand and gravel, gem stones.
Park	(2)	325,260	Sand and gravel, stone, beryllium concentrate, peat, lead, silver, zinc, gem stones, uranium ore, copper, gold.
Phillips	381,126	7,050	Sand and gravel, gem stones.
Pitkin	(2)	(2)	Coal, sand and gravel, natural gas, lead, zinc, silver.
Prowers	100,500	124,000	Sand and gravel.
Pueblo	983,170	1,925,045	Sand and gravel, lime, clays, stone, zinc, lead, silver, copper, gold, gem stones.
Rio Blanco	[3] 57,952,472	57,053,135	Petroleum, natural gas liquids, natural gas, sand and gravel, coal, uranium ore, vanadium.
Rio Grande	(2)	29,613	Sand and gravel, gem stones.
Routt	2,629,937	3,315,135	Coal, petroleum, sand and gravel, pumice, stone.
Saguache	(2)	1,337,506	Uranium ore, sand and gravel, gem stones, stone, zinc, lead, silver, copper.
San Juan	475,757	1,947,028	Zinc, lead, silver, copper, gold, gem stones.

Footnotes at end of table.

TABLE 22.—Value of mineral production in Colorado, by countries—Continued

County	1962	1963 [1]	Minerals produced in 1963 in order of value
San Miguel	$10,762,586	$11,073,258	Vanadium, uranium ore, zinc, lead, copper, silver, gold, sand and gravel, iron ore, petroleum, gem stones.
Sedgwick	155,594	225,000	Lime, sand and gravel, natural gas.
Summit	268,235	643,296	Zinc, lead, sand and gravel, stone, silver, gold, copper, gem stones.
Teller	[2]	202,442	Sand and gravel, peat, stone, gem stones.
Washington	27,570,584	21,929,054	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Weld	9,573,843	9,573,308	Petroleum, coal, sand and gravel, natural gas, lime, natural gas liquids, stone, gem stones.
Yuma	115,600	216,000	Sand and gravel.
Undistributed [4]	[3] 7,855,751	7,710,276	
Total	[3] 308,164,000	317,109,000	

[1] Petroleum value is preliminary.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Revised figure.
[4] Includes some stone (1963), sand and gravel (1962), and gem stones that cannot be assigned to specific counties and values indicated by footnote 2.

The quantity of gold and silver recovered from sand and gravel washing plants was slightly above that of 1962. The Great Western Sugar Co. produced quicklime for use in sugar refining. Contractors produced crushed miscellaneous stone for the State highway department for road construction. Skelly Oil Co. closed its 1,700-barrel-per-day refinery at Derby in October. Throughput at the refinery for 10 months was 25 percent below that of 1962. The company began a modernization program at its El Dorado, Kans., refinery; all operations at the Derby plant were transferred to the expanded facility at El Dorado. The move, dictated by economics, was expected to reduce operating costs substantially.

Alamosa.—Oriental Refining Co. operated its 1,100-barrel-per-day refinery at Alamosa. Crude-oil throughput, largely from fields in northwestern New Mexico, was 1 percent below that of 1962. Paving sand and gravel for road repairs and maintenance was produced by the State and county highway departments.

Arapahoe.—The county was ranked sixth in the State in the output of sand and gravel. Production was by six commercial operators at seven operations and by contractors and crews of the State highway department and crews of the county highway department. Commercial output was used mainly as building sand, building and paving gravel, and fill gravel. Principal producers were Cooley Gravel Co., operating two plants; Herbertson Sand and Gravel Co.; and Brannan Sand & Gravel Co. Cooley Gravel Co. began operating an improved floating preparation plant at one of its localities on the South Platte River. The plant, named "Gravel Gertie IV," the fourth of a series of similar plants developed over 30 years, consisted of a suction pump and chain-type digging-ladder dredge attached to the floating preparation plant by a ball-and-socket joint that permitted the dredge to swing through its digging arc, independent of the washing plant. The plant was designed to solve operating difficulties caused by clay and mud seams and a tangle of roots, brush, and tree stumps contained in the sand and gravel deposit. Because the deposit also contained an excessive amount of coarse sand, rigid specifications of particle gradation were met by carefully sizing the material, discarding the excess of coarse sand, and combining the remaining material in the

proper proportions. Operation of the plant was highly successful; however, because of poor caving conditions due to seams of mud and clay, production did not meet design specifications of 1,000 tons per hour. Crushed miscellaneous stone was produced by contractors for the State highway department.

Archuleta.—Crude-petroleum production from 31 wells in the Chromo and Price Gramps fields was only slightly below that of 1962. Paving gravel was produced by C. B. Johnson Gravel Products Co. Contractors produced paving gravel and crushed and broken stone for the State highway department.

Baca.—Petroleum production from the seven-well Flank field was 28 percent above that of 1962; natural gas output from Greenwood, Prairie Dog, and Walsh fields was 16 percent greater than in 1962. Contractors produced crushed stone, and Government crews produced paving sand for the State highway department.

Bent.—Petroleum and oil-well gas outputs from the Bent's Fort, Lubers, and McClave fields were 100 and 8 percent, respectively, above those of 1962. The oil-well gas was processed at a plant in Kiowa County. Graham Construction Co. produced gravel for building, paving, and miscellaneous uses. Carbon dioxide from wells in Las Animas County was processed at a plant at Ninaview.

Boulder.—Total value of mineral production was 18 percent below that of 1962. The value of output of lime, sand and gravel, and stone gained significantly. Substantial declines in the value of clays and fluorspar were not offset by gains in other commodities.

The output of sand and gravel by four commercial operators and by Government crews and contractors was 17 percent above that of 1962. Bailey Construction Co., Boulder Gravel Products, Inc., Golden Transfer Co., and Pendleton Construction Co. produced building sand, building and paving gravel, and miscellaneous gravel. State highway department crews produced paving gravel; contractors produced paving sand for the Federal Bureau of Public Roads and paving gravel for the Federal Forest Service and the Colorado Department of Highways. Output of stone (crushed and dimension sandstone and crushed miscellaneous stone) was from eight commercial and two Government-and-contractor operations. Crushed sandstone for concrete aggregate and road construction was produced by King Mountain Rock Co. and Sterling Stone Co. From a large quarry near Lyons, the King Mountain Rock Co. produced in excess of 29,000 tons of high-specification aggregate having 100-percent fractured faces. Dimension sandstone was produced at six operations. The pink to red quartzitic sandstone of the Lyons formation was used extensively for building facings and other construction purposes. The University of Colorado quarried the Lyons sandstone for buildings on the university campus at Boulder. Crushed miscellaneous stone was produced by a contractor of the State highway department. Quicklime produced by The Great Western Sugar Co. for use in sugar refining was 20 percent above that of 1962. Output of fluorspar at the Burlington mine at Jamestown and the 150-ton-per-day flotation plant at Valmont operated by General Chemical was drastically curtailed compared with that of 1962. Production was limited to meet company requirements in manufacturing hydrofluoric acid.

Production of miscellaneous clay and shale for manufacturing building brick and tile, produced by Colorado Brick Co. and El Dorado

Clay Co. in 1963, was below that of 1962. Crude petroleum from four wells in the Boulder field declined. No drilling was reported during the year, and one well in the field was abandoned. Peat production, for use as a soil conditioner and for admixture with organic fertilizers, also declined. Gold and silver were produced at the Rex mine by Steen Mining Co. and at the Slide mine by Frank Marcello. Output of uranium ore at the Fair Day mine by Roy Busby and Modern Minerals, Inc., was below that of 1962. Part of the ore contained sufficient vanadium to warrant recovery. Individuals collected specimens of autunite, jasper, and malachite.

Chaffee.—Production of crushed and dimension granite and crushed sandstone and limestone accounted for more than 75 percent of the total value of mineral output in the county. Colorado Granite Co. produced rough monumental granite. Joe Carnigee produced crushed granite for use as an ornamental aggregate, and Ralph Pierce produced crushed sandstone for use in precast shapes. CF&I produced limestone at its Monarch quarry for use as a flux in steelmaking and for manufacturing lime also used in steelmaking.

Hart Rok Redi Mixt Concrete produced building sand and gravel. Graham Construction Co. produced gravel for paving and miscellaneous uses. County highway crews produced paving sand and fill gravel. Contractors produced paving gravel for the Federal Forest Service.

Production of feldspar in the county virtually ceased at the end of the year. Western Feldspar Milling Co., which had been operating for 30 years, announced that declining markets and increased competition with larger and better equipped plants closer to points of consumption had forced liquidation; the company sold its grinding plant at Salida at auction in November. M. & S., Inc., operating the Homestake mine owned by Western Feldspar Milling Co., the only producer in the county and the major producer of feldspar in the State, moved its operation to Sedalia in Douglas County to engage in preparing crushed rock for decorative purposes. Individuals, mineralogical societies, and dealers collected a variety of gem stones, gem material, and mineral specimens.

Clear Creek.—The value of mineral production was nearly three times greater than that of 1962. Increases in the output of silver (fourfold), copper (twofold), lead (fourfold), and zinc (fivefold) accounted for the gain. Gold production, continuing to decline, was 50 percent below that of 1962. Output of sand and gravel declined by 50 percent. Because highway construction on Interstate 70 west of Idaho Springs and the driving of the pioneer base of the Straight Creek Tunnel were largely rock removal, requirements for sand and gravel were reduced. The only production was paving gravel by crews of the State highway department for maintaining State highways in the county.

Major producers of silver, copper, lead, and zinc were Humphreys Engineering Co. at the Cascade mine, Cascade and Ute Creek district; P & M Mining Co. at the Hamill Tunnel, Argentine district; and Bur-Jay Minerals, Inc., at the Burleigh and Diamond Tunnels, Argentine district. Other producers included Globe Hill Mining Co. at the Johnny Bull and Allen L. Simons at the Smith Wesson, both in the Griffith district, and Silver Wreath Mines Co. at the Fairmont, Idaho Springs district. Atlas Milling & Mining Co.—organized to operate

mines in the Idaho Springs, Silver Plume, and Griffith districts—began rehabilitating and improving the Black Eagle mill on Chicago Creek, south of Idaho Springs. The company planned to mill ores of its own production and to establish a custom-milling facility.

Custer.—The value of mineral output dropped 55 percent compared with that of 1962. Output of perlite declined significantly: production of sand and gravel also fell. Persolite Products, Inc., operated its Rosita quarry and processed the crude material in its plant at Florence in Fremont County. Graham Construction Co. produced gravel for building, paving, and miscellaneous uses. Contractors produced paving gravel for the Federal Forest Service, and State highway department crews produced paving gravel for maintaining State highways. The Lawson clay pit operated by H. K. Porter Co., Inc., in 1962 was idle in 1963. Crude vermiculite produced by Insuplast, Inc., at its mine near Westcliffe was processed at its plant at Canon City for use in insulation and sound control. Agate, petrified wood, and quartz crystal were collected by the Colorado Springs Mineralogical Society at Silver Cliff.

Delta.—Coal production from five underground mines was 47 percent below that of 1962. The major producer was The Juanita Coal & Coke Co. at the King mine. Sand for building and fill and gravel for building, paving, and miscellaneous uses were produced by Delta Sand and Gravel Co. Government crews and contractors produced paving sand and gravel for the State and county highway departments. Holly Sugar Corp. produced quicklime for use in sugar refining.

Denver.—Oil refineries within the city and county of Denver were operated by Continental Oil Co., Empire Petroleum Co., Oriental Refining Co., and Tenneco Oil Co. Throughput was 12.3 million barrels, a 3-percent gain over that of 1962. Paving gravel was produced by Brannan Sand & Gravel Co. from a pit in the southwestern part of the county recently annexed to the city and county of Denver. Before the annexation, there had been no mineral production within the county for a number of years. Much of the nonmetal output of adjacent and other counties—sand and gravel, clays, perlite, vermiculite, and gypsum products—was used in construction projects and at the plants and factories within Denver County.

Asarco operated the Globe plant and recovered cadmium, thallium, and other metals and compounds from flue dust, dross, and similar materials shipped from other smelters and processing plants. At its plant in Denver, General Chemical produced sulfuric acid from pyrites produced in Lake County.

Dolores.—Output of gold, silver, lead, and zinc from the Argentine and Mountain Spring mines and Rico mill in the Pioneer mining district, operated by Rico Argentine Mining Co., was lower than in 1962. Copper production remained the same. Because of increased prices for silver and lead, the decrease in output value was not as great as the drop in output. The company engaged in mine-exploration and development activities. Pyrites from these mines were used at the company-owned Ramco acid plant north of Rico for manufacturing sulfuric acid. The acid was used primarily by the various uranium-ore processing mills in Colorado and New Mexico. Because operations at the uranium mills were curtailed, the demand for sulfuric acid was lower and, consequently, the plant was idle part of the year. Extensive repairs were required at the plant. Plans were

made for an increased production of the base metals. Small quantities of gold and silver were produced by T. S. Wolverton and Sterling, Inc. Contractors produced paving gravel for the State highway department, and Government crews produced paving sand and gravel for the county highway department.

Douglas.—The total value of mineral production increased 11 percent over that of 1962. Building sand, building and paving gravel, and fill gravel were produced by Hall Sand & Gravel, Inc., Pre Mix Concrete, Inc., and Tower Construction Co. Waterton Sand & Clay produced industrial sand for foundry uses. Paving gravel was produced by crews of the county highway department and by contractors for the State highway department. Fire and miscellaneous clay was produced by Denver Brick & Pipe Co. at the Ringenberg pit; Helmer Brothers at the Helmer; Robinson Brick & Tile Co. at the Hogback, Pioneer, and Ute; and Stroud E. Whisenhunt at the Stevens and Stroh. Except for a small quantity of fire clay used by foundries, the entire output was consumed in manufacturing building brick and tile, sewer tile, and other heavy clay products at plants in Denver. Peter Kiewit Sons' Co. produced crushed and broken granite for riprap and for road construction for the Federal Forest Service and a contractor produced broken miscellaneous stone used as riprap for the State highway department. L. N. & F. A. Johnson produced rough building stone. Mineral societies and individuals collected quartz and topaz at Devils Head and petrified wood at Franktown.

Eagle.—Total value of mineral production was slightly below that of 1962. The New Jersey Zinc Co. produced lead-zinc and copper ores at its Eagle mine at Gilman. The mine was ranked first in the State in the output of zinc and second in output of gold, silver, copper, and lead. Building sand and gravel was produced by Glenwood Aggregate Co. and Zemlock & Son. Contractors produced paving sand for the county highway department; county and State crews produced paving gravel. Paving gravel was produced by contractors for the Federal Forest Service and the State highway department. Volcanic cinders and pumice were produced by Lava Products, Inc., and Roaring Fork Pumice Co. Crushed stone was produced by contractors for the State highway department. Dimension sandstone used as dressed building stone was produced by H. E. Gordon. Gem societies and individuals collected a variety of mineral specimens.

El Paso.—The value of mineral production was 33 percent above that of 1962. Increases were recorded in the value of sand and gravel, lime, clay, and gem stones. Government crews produced paving sand and gravel for the State and county highway departments and the city of Colorado Springs. Paving gravel was produced by contractors for the State highway department. Building and paving sand, paving gravel, and fill sand and gravel were produced by five commercial operators. Major producers were Daniels Sand Co., Broderick & Gibbons, Inc., and Rocky Mountain Oil Paving, Inc. Total output of sand and gravel was in excess of 1 million tons. Crushed and broken limestone was produced by Castle Concrete Co. for riprap, concrete aggregate, and decorative gravel cover and by Colorado Lime Co. for manufacturing hydrated lime for building and industrial uses. Output of lime was 3 percent above that of 1962. Springs Silica Sand Co. produced crushed sandstone for refractory

and foundry uses. Contractors produced crushed and broken miscellaneous stones for the State highway department.

Fire and miscellaneous clay produced by The National Clay Products Co., Standard Fire Brick Co., and Robinson Brick & Tile Co. were used for manufacturing building brick, sewer tile, and other heavy clay products. Coal production at the Franceville strip mine was 47 percent below that of 1962. Herbert E. Smith produced beryllium concentrate (beryl) at the Lone Pine Hill Top mine. Gem societies and individuals collected agate, agatized and petrified woods, and quartz. Don Pence mined a substantial quantity of zircon crystals. Total value of gem material collected was $20,085.

Fremont.—The value of mineral production was 5 percent below that of 1962. Gains were recorded in the value of output for clay and sand and gravel; declines in value of production were recorded for other commodities, most of them minor. Value of beryllium concentrate and uranium ore declined substantially.

Shipments of portland and masonry cements by Ideal Cement Co. from its plant at Portland were nearly 1 percent below that of 1962. The company produced the crushed limestone and sandstone used in manufacturing cement. Cement clinker was used as a base for manufacturing masonry cement. Stone output, other than that used for cement, included crushed granite produced by a lessee of Colonna & Co. of Colorado, Inc., for use as an ornamental aggregate. The company also produced crushed marble at its Canon City and Salida quarries for use as terrazzo chips; Cowan Bros. produced dimension marble; O. L. Braly produced crushed miscellaneous stone for concrete aggregate; and contractors produced broken stone for the State highway department. Crushed sandstone was produced by American Mining & Milling Corp. for use as roofing granules; by H. K. Porter Co., Inc., Standard Fire Brick Co., and Ray Sturbaum for refractory (ganister) use; and by Lockhart & Sons and Ralph J. Pierce for use as an aggregate in precast shapes and landscaping. CF&I produced crushed limestone for use as flux and in manufacturing lime and Frank H. Norberg Co. for road construction and in manufacturing lime. Coal production from 16 underground and 3 strip mines was 3 percent below that of 1962. Major producers were The Corley Co. at the Pioneer Canon Nos. 2 and 3 underground mines and the Corley strip mine, Canon Black Diamond Coal Co. at the Canon Black Diamond mine, Vento Coal Co. at the Vento mine, Golden Quality Coal Co. at the Golden Quality No. 4 mine, and Beer Coal and Construction Co. at the Beer strip mine.

Pabco Building Materials Division, Fibreboard Paper Products Corp., produced gypsum, part of which was calcined for manufacturing gypsum board products. Crude gypsum was used as a retarder in manufacturing portland cement. U.S. Soil Conditioning Co. produced crude gypsum for agricultural use. Fire clay production by H. K. Porter Co., Inc., at the Flint mine, Irvin Clay Co. at the Irvin mine, and George O. Stroup at the 8 Mile and Phantom Canyon mines was 28 percent above that of 1962. H. K. Porter Co., Inc., manufactured firebrick and block; Irvin Clay Co., firebrick and block, building brick, and other heavy clay products. Output by George O. Stroup was used for manufacturing building brick. Glen Lamberg & Sons produced bentonite at the Triangle-Lamberg mine for use as a sealer in stock ponds and irrigation ditches. Building and paving sand and gravel and gravel for miscellaneous uses was produced by Sing's Sand & Gravel Co. Ralph Pierce produced building gravel. Building

gravel and sand and gravel for fill was produced by the State penitentiary at Canon City. Government crews produced paving gravel for the State and county highway departments and the city of Canon City. Contractors produced paving gravel for the State highway department. Crude petroleum from 20 wells in the Florence-Canon City field, the second oldest in the Nation, was 10 percent below that of 1962. Production had been from the relatively shallow Pierre formation, and an exploratory well designed to test the deeper Mississippian formation was a failure. Precambrian formations were encountered at a depth of 8,465 feet; the well was continued to a total depth of 8,815 feet where Precambrian granite was reached. Mississippian formations were cut for 340 feet from 8,125 feet to the Precambrian. There were no indications of oil.

Uranium ore production from the Joan mine by Seacol Corp., the Last Chance and Picnic by C. B. Johnson, Inc., and from the Little Abner by Smaller Mining Co. dropped 76 percent below that of 1962. The ore was processed at the Cotter Corp. plant in Canon City and at mills in Grand Junction and Rifle. A small quantity of vanadium contained in the ore was recovered from the material processed at Grand Junction and Rifle. Cotter Corp. added a flotation pilot section to its uranium processing mill at Canon City for treating low-grade silver-lead-zinc ores from the Silver Cliff-Rosita area. The company, engaged in exploring and sampling idle mines, acquired the Lady Franklin and Passiflora mines at Silver Cliff which were being developed. O. L. Braly produced perlite, the first recorded in the county. The output was used by Colonna & Co. of Colorado, Inc., for exposed aggregate. Lockhart & Sons produced feldspar at the Mica Lode mine. Ralph Pierce produced beryllium concentrate (beryl) at the Black Hawk mine and shipped to Beryl Ores Co. for processing. Gem stones and mineral specimens were collected by individuals and dealers.

Garfield.—Coal production from three underground mines was 23 percent below that of 1962. Natural gas from 21 wells in 6 fields declined 13 percent. Major production was from the South Canyon, Garmesa (three horizons: Dakota, Morrison, Entrada), and Rulison fields. Output of quicklime and hydrated lime by Basic Chemical Corp. was substantially more than that of 1962. Major uses were in building construction and ore concentration and for manufacturing insecticides. The company produced crushed limestone for its own use in manufacturing lime, for use as a flux, in mineral food, and for rock dust in coal mines. Frank H. Norberg Co. produced crushed limestone for concrete aggregate and for manufacturing lime. Building and paving sand and gravel and fill sand were produced by Coulter Construction Co. and Zemlock & Son. Union Carbide Nuclear Co. operated its 1,000-ton-per-day uranium-vanadium processing plant at Rifle. Because of readjustment of operating schedules to meet AEC requirements of uranium oxide procurement, the Rifle mill was operated primarily for recovering vanadium and small amounts of uranium oxide. Uranium-oxide recovery was the major function of the company plant at Uravan in Montrose County.

Gilpin.—Value of mineral output, continuing to decline, was less than that of 1962. Output of gold, silver, copper, and lead were below that of 1962; output of zinc increased fourfold. Virtually all of the gold produced was recovered at six placer operations, most of which

were panning and sluicing of stream and bench gravels by hand methods. Greatest output was by R. F. Zacker at the Bobtail where a power shovel, trommel screen, and sluice boxes were used. Gold, silver, copper, lead, and zinc were from the Carroll mine operated by Klame Corp. and silver and lead from the P. R. No. 7 operated by Douglas Perkins. Although numerous mines, long idle, were examined and some rehabilitation work done, there was no production in 1963. The Golden Gilpin mill at Black Hawk was leased by Globe Hill Mining Co., operating the Johnny Bull mine at Silver Plume. The company rehabilitated the mill to concentrate ore from the Johnny Bull mine. Output of peat for use as a soil conditioner and as an admixture for organic fertilizer was 36 percent above that of 1962.

Gunnison.—Coal production from eight underground mines declined 20 percent below that of 1962. Major producers were Bear Coal Co. at the Bear mine; Columbia-Geneva Steel Division, United States Steel Corp., at the Somerset; Champion Coal Mining Co. at the Hawk's Nest; Nu-Mine Coal Co. at the Nu-Mine No. 2; and Ellis Coal Co. at the Black Beauty. Output of gold declined to 81 ounces compared with 106 ounces in 1962; however production value of silver, copper, lead, and zinc was $1 million compared with $384 for silver and lead in 1962. The Keystone mine near Crested Butte, idle since 1957, was leased by McFarland & Hullinger, mine contractors. Operations began in May. Other producers were Smoky Ward Mining Co. at the Anaconda, Rocky Mountain Mining Co. at the Micawber, and Don Knight of Carbondale. Building sand and gravel and fill gravel was produced by Gunnison Ready-Mix Concrete Co., Inc. Contractors produced building gravel and paving sand and gravel for the Federal Bureau of Reclamation, Federal Forest Service, and the State highway department. Government crews produced paving gravel for State and county highway departments. Total output of sand and gravel was nearly double that of 1962. Industrial Minerals Corp. produced crushed marble for use as roofing granules. John H. Hahn and the county highway department produced crushed stone for concrete aggregate; contractors produced crushed stone for the State highway department. Tomichi Village produced rough and finished dimension sandstone. Total stone output increased substantially over that of 1962. Robert Heberer collected specimens of petrified wood and moss opal.

A report [7] of investigations was published on the Cebolla Creek titaniferous iron deposit to make a preliminary determination of sampling requirements for the deposit.

Huerfano.—Coal production from four underground mines was 3 percent below that of 1962. Delcarbon Coal Co. operated the Calumet No. 2 mine; Red Ash Coal Co., the Maitland No. 2; Morning Glory Coal Co., the Morning Glory; and Skinner Coal Co., the Gordon. Standard Fire Brick Co. produced fire clay at the Chamblin mine for manufacturing sewer tile and fire clay mortar. Domenic Leone Construction Co., Inc., produced building gravel. Contractors and government crews produced paving sand for the Bureau of Public Roads. State highway department crews produced paving sand and gravel for maintenance work. Increasing fourfold over that of 1962, ura-

[7] Burkenkotter, R. D., and Scott W. Hazen, Jr. Statistical Analysis of Diamond-Drill Sample Data From the Cebolla Creek Titaniferous Iron Deposit, Gunnison County, Colo. BuMines Rept. of Inv. 6234. 1963, 58 pp.

nium ore produced at the Stumbling Stud mine by Mills & Briscoe was processed at the Cotter Corp. plant at Canon City.

Jackson.—Petroleum output was from 41 oil wells in 4 fields. Major production was from the Dakota-Lakota, Morrison, and Muddy horizons at the McCallum field. Natural gas production was from two wells at the Canadian River-Muddy field. Carbon dioxide produced with petroleum at the McCallum and McCallum South fields was vented. Government crews produced paving gravel for the Federal Forest Service and State and county highway departments. Contractors produced paving gravel and crushed stone for the State highway department. Fluorspar and vermiculite mines were idle in 1963.

Jefferson.—Mineral production valued at $3.9 million was 15 percent below that of 1962. Declines in output and value were recorded in all mineral commodities produced: gold and silver production recovered from sand and gravel operations were 25 and 31 percent, respectively, below that of 1962. Output of fire and miscellaneous clays and shale from 17 operations by 12 operators was 15 percent below that of 1962. The Idealite Co. and Clalite Concrete Products, Inc., produced miscellaneous clay and shale for manufacturing lightweight aggregate. Miscellaneous clay for manufacturing building brick and tile, sewer tile, and other heavy clay products was produced by George W. Parfet Estate, Inc., Lakewood Brick & Tile Co., Colorado Brick Co., and H. M. Rubey Clay Co. Fire clay for manufacturing building brick and tile and other heavy clay products was produced by Robinson Brick & Tile Co., Denver Brick & Pipe Co., and John L. Harvey. Denver Fire Clay Co. produced fire clay for manufacturing firebrick and block, high-alumina brick, clay crucibles, and other refractory products. Sand and gravel for building, paving, fill, railroad ballast, and miscellaneous uses was produced by 10 commercial operators at 12 locations. Major producers were Asphalt Paving Co., Rio Grande Gravel Co., Western Paving Construction Co., Kilgroe-Atchinson Construction & Paving Co., Lee Sand & Gravel Co., and Brannan Sand & Gravel Co. Crews of the State highway department produced paving gravel.

Crushed sandstone and granite were produced by six operators. Sized chips—termed "exposed aggregates"—were used for ornamental purposes on the surface of precast panels. Output of uranium ore from five operations was 9 percent below that of 1962. Denver-Golden Corp. operated the Schwartzwalder mine, Cotter Corp. operated the Foothills mine and Wright Lease, Yellow Queen Uranium Co. operated the Ascension mine, and Leigh D. Ohman operated the Nare Lease. The entire production was processed at the Cotter Corp. plant at Canon City. Gem stones and mineral specimens were collected by mineral societies, dealers, and individuals. Although no beryllium concentrate (beryl) production was reported in 1963, Beryl Ores Co., Arvada, purchased material from producers in other counties and operated its plant, manufacturing high-grade beryllium compounds and products for ceramics and other uses.

Kiowa.—Petroleum production from two wells in the Brandon field was 21 percent below that of 1962. Natural gas from the McClave field increased substantially over that of 1962. The number of producing wells in the field increased from 6 in 1962 to 17 in 1963. Fleetwood Drilling Co. completed its natural gas processing plant at the McClave field and began operations in July. The plant was operated

through October and recovered natural gasoline and mixed butane and propane. Contractors produced crushed stone for the State highway department. No sand and gravel production was reported in 1963.

Lake.—The value of mineral production was $68.1 million, an impressive gain of 45 percent over that of 1962. Following settlement of a nearly 6-month strike on January 9 at the Climax Molybdenum Co. molybdenum mine at Climax, the 1963 value of output was 6 percent above that of 1961 when the Climax mine was operated the full year.

The mine and mill were operated virtually the entire year on a 7-day-per-week basis. Rock pressure developed over a part of the mine where higher grade material was being mined, and some curtailment of output from that area was necessary; thus mill feed was of a lower grade. To offset the reduction in average grade, output from other parts of the mine was increased to a daily average of 35,500 tons of crude ore. Because of the lower grade of ore processed at the mill, the recovery of molybdenum was 47.4 million pounds, slightly below that of the prestrike years 1960–61. A new milling unit was put into operation early in 1963 to handle the additional tonnage; another unit was being installed for use early in 1964. In anticipation of virtual exhaustion of minable ore above the Phillipson level in the 1970's, progress continued in developing a new mining level below the Phillipson and Stork levels.

Development of the Ceresco Ridge ore zone contiguous to the Climax mine continued, and production at a rate of 5,000 tons per day was planned for 1965. Plans were completed to proceed with the design, engineering, and construction of a unit to recover oxidized molybdenum by a new hydrometallurgical process, developed through extensive research over the past 2 years, the first of its kind for molybdenum. The unit, when completed in 1966, was to process about 5,000 tons of material per day and recover about 3 million pounds of molybdenum per year.

Byproduct tin, tungsten, and pyrites were recovered at the Climax mine. The tin concentrate and low-grade tungsten rejects were sold to Fred P. Lenway & Co., Inc., of San Francisco, Calif., for upgrading at the Marion mill in Boulder County. Tungsten concentrate, containing in excess of 70-percent tungsten oxide, was sold to Eastern plants for manufacturing tungsten alloys. Pyrite was shipped to General Chemical for manufacturing sulfuric acid at its plant at Denver.

Gold, silver, copper, lead, and zinc were recovered at cleanup operations at the Arkansas Valley smelter and the Resurrection mill. The quantity recovered was below that of 1962 except for zinc, which was slightly higher.

C. Ryan & Son produced building sand and building and paving gravel. Specimens of muscovite, molybdenite, and pyrite were collected by individuals and dealers.

La Plata.—Natural gas and crude petroleum production from 407 gas wells and 22 oil wells in 8 fields was 7 and 2 percent, respectively, above that of 1962. Dry natural gas was from the Ignacio-Blanco field, producing from the Dakota, Fruitland-Picture Cliffs, and Mesaverde formations. Petroleum and oil-well gas were from the Red Mesa field, producing from the Dakota-Lakota, Gallup, and Mancos formations. No exploratory drilling was done during the

year; however, development drilling added 40 gas wells to the Ignacio-Blanco field and 3 oil wells to the Red Mesa field from 44 wells completed. El Paso Natural Gas Co. operated its San Juan natural gas plant at Ignacio; throughput at the plant was 19.6 billion cubic feet. Natural gas liquids (natural gasoline, butane, propane) were recovered from oil-well gas treated. The plant, however, functioned primarily as a pressure-maintenance station; dry natural gas from the Ignacio-Blanco field was passed through the plant compressors without processing.

Coal production from seven underground mines was 17 percent below that of 1962. Principal production was from the King Coal, Victory No. 3, and Burnwell No. 1 mines. Building sand and building and paving gravel were produced by Animas Valley Sand & Gravel, Inc., Burnett Construction Co., and C. B. Johnson Gravel Products Co. Government crews and contractors produced paving gravel for the State highway department. Crushed granite was produced by Burnett Construction Co. for road construction and by J. D. Simmons for road construction, for terrazzo, and for the Federal Forest Service. No production of gold, silver, copper, lead, or zinc was reported in 1963. VCA acquired Kerr-McGee Oil Industries, Inc., Navajo uranium-vanadium processing plant at Shiprock, N. Mex., and closed its plant at Durango on March 1. The Durango plant was being dismantled and all uranium-vanadium material shipped to Shiprock for processing. VCA produced crude limestone for metallurgical use.

Larimer.—Ideal Cement Co. operated its Boettcher plant at La Porte; shipments of portland cement were 6 percent below those of 1962. From a nearby quarry, the company produced limestone used at the plant. Frank H. Norberg Co. and Pinon Grove Lime Co. produced crushed limestone for manufacturing cement and lime. Dimension sandstone—rough and dressed building stone—was produced by 11 operators at 14 quarries. Major producers were Sterling Stone Co., Colorado Stone Co., Berthoud Pink Stone Co., and Arthur Ohline. Sterling Stone Co. produced crushed sandstone for road construction; contractors produced riprap for the Bureau of Reclamation for use on South Platte River Projects. Rocky Mountain Quarry Co. produced rough granite blocks for monuments. Contractors produced crushed stone for the State highway department. Sand and gravel for building, paving, railroad ballast, fill, and miscellaneous uses was produced by five operators, principally by Weitzel Sand & Gravel, Sterling Sand & Gravel Co., and Western Paving Construction Co. Building sand and paving sand and gravel were produced by Government crews and contractors for the State and county highway departments, Federal Bureau of Reclamation, and Federal Bureau of Public Roads.

Petroleum output from 43 wells in 9 fields was 49 percent above that of 1962, principally from the Ft. Collins and Wellington fields. The Great Western Sugar Co. produced quicklime for sugar refining. Crude gypsum was mined at the Goodwin quarry by Ernest K. Munroe for use as a retarder in portland cement, and United States Gypsum Co. operated its Loveland quarry. Jolex Mica Co., Inc., produced scrap mica at the Langston mine. The crude mica was dry ground at the company plant at Ft. Collins for use in manufacturing roofing and for well drilling. A variety of mineral specimens and gem stones was collected by individuals and mineral societies in the vicinity of Crystal Mountain, Loveland, and Red Feather Lakes.

Las Animas.—Output of bituminous coal from 10 underground mines was 13 percent above that of 1962. Production by CF&I at the Allen mine, the largest in the State, was used by the corporation for manufacturing coke at its steel plant at Pueblo. Building and paving sand and gravel and railroad ballast were produced by Ozello Construction Co. and Leone Sand & Gravel. Government crews produced paving gravel for State and county highway departments. Fire clay produced by Harbison-Walker Refractories Co. at its Trinidad mine and by Scott Mining Co. at the Santa Fe mine was used for manufacturing firebrick and block. Empire Clay Products, Inc., produced miscellaneous clay for manufacturing building brick. Carbon dioxide produced at the 2-well Nina View field was processed at a plant in Bent County for conversion into dry ice and liquid carbon dioxide. A variety of mineral specimens was collected by individuals.

Logan.—Mineral fuels—petroleum, natural gas, natural gas liquids—represented 98 percent of the total value of mineral production in the county. Crude pretroleum, oil-well gas, and dry natural gas were from 386 oil wells and 5 gas wells in 87 fields. Petroleum output, 9 percent below that of 1962, was principally from the Northwest Graylin, Lewis Creek, East Atwood, and Yenter fields. The 4-well Springdale field was used for gas storage by the Kansas-Nebraska Natural Gas Co. Natural gas plants, operated at the Lewis Creek, Padroni, and Yenter fields by Associated Oil & Gas Co. and at the Minto field by Sunray-DX Oil Co., recovered natural gasoline, butane, and propane. The residual gas was marketed through pipelines. Throughput at the plants was 5.9 billion cubic feet of oil-well gas.

Four operators produced gravel for miscellaneous uses and building, paving, and fill sand and gravel. Principal output was by Sterling Ready Mix Concrete Co. and Northeastern Sand & Gravel. County highway department crews produced paving gravel and fill sand. Contractors produced paving gravel for the State highway department. The Great Western Sugar Co. produced quicklime for use in manufacturing sugar. Contractors produced crushed stone for the State highway department. Mile-Hi Rock & Mineral Society collected specimens of agate near Sterling.

Mesa.—Output of uranium ore from 46 operations was 2 percent below that of 1962 from 50 operations. Climax Uranium Co. operated its uranium-vanadium processing mill at Grand Junction at a lower rate in anticipation of reduced production to meet the schedule of procurement established by AEC under the 1966–70 stretchout program. The plant also recovered vanadium from the uranium ores, and greater attention was given ores of higher vanadium content because of the reduced procurement of uranium oxide by AEC.

Coal was produced at four underground and one strip mine. Major production was at the Cameo mine by Kerr Coal Co. The entire output was delivered by conveyor belt to the PSC Cameo powerplant at the mine site. Natural gas was from 25 wells in 12 fields, principally the Divide Creek, Buzzard Creek, Buzzard, and Plateau. A natural gas processing plant was being built north of Grand Junction by Continental Oil Co. and Western Slope Gas Co., a subsidiary of PSC. The plant, to have a daily throughput capacity of 20 million cubic feet of gas, was to process gas from fields north of Grand Junction and remove natural gasoline, butane, and propane. Residual gas was to be marketed by Western Slope Gas Co., in the Grand

Junction area. Of six exploratory wells completed, two were discoveries in the Dakota formation and one in the Mesaverde. Initial production ranged from 325,000 to 5.2 million cubic feet of gas per day. Six development wells were completed, of which five were successful. Building and paving sand and gravel and fill and miscellaneous gravel were produced at six plants by three operators. Whitewater Sand & Gravel Co., the largest producer, operated four plants. Other operators were United Sand and Gravel Co. and Fruita Ready Mix Sand & Gravel. Paving sand and gravel and fill gravel were produced by crews of the county highway department. Government crews and contractors produced paving gravel for the State highway department. United Stone Products Co. produced rough and dressed dimension sandstone for building and flagging. Contractors produced broken stone for the State highway department. Individuals collected mineral specimens and dinosaur bones.

Mineral.—Output of gold, silver, copper, lead, and zinc from the Emperius (Amethyst and Commodore) mine was below that of 1962. The mine was idle from the first part of the year until May 15, when operations were resumed. Output of sand and gravel dropped from 43,000 tons in 1962 to 5,000 tons in 1963. County highway department crews produced paving gravel for repairs and maintenance. Individuals and mineralogical societies collected specimens of agate near Creede.

Moffat.—Uranium ore from 31 mines operated by Union Carbide Nuclear Co. was 14 percent above that of 1962. The company operated its uranium processing plant at Maybell throughout the year. Crude ore for the plant was from the company-owned mines in Moffat County and from mines in Wyoming.

Petroleum and natural gas was from 107 oil wells and 22 gas wells in 24 fields. Principal production was from the Williams Fork, Moffat, Iles, and Danforth Hills fields. Natural gas, largely from the Hiawatha and Powder Wash fields, was passed through plants at the fields for the removal of moisture and improvement of the quality of the gas which was marketed through pipelines of the Mountain Fuel Supply Co. A small quantity of natural gas liquids was recovered at the plants.

Bituminous coal production from the Red Wing mine operated by Colowyo Coal Co. and Wise Hill No. 3 mine operated by Silengo Coal Co. was 24 percent above that of 1962. Building and paving sand and gravel and fill gravel were produced by Craig Sand & Gravel Co. Paving sand and gravel was produced by Government crews for the State and county highway departments. Contractors produced paving gravel and crushed stone for the State highway department. Mineral societies and individuals collected mineral specimens.

Montezuma.—Petroleum and natural gas production from 14 oil wells and 2 gas wells in 7 fields was 58 and 87 percent, respectively, above that of 1962. Major output was from the Flodine Park and Towaoc fields. Carbon dioxide from the 1-well McElmo (Mississippian) field was converted to dry ice and liquid carbon dioxide at the Colorado Carbonics Corp. plant at McElmo. Building sand and gravel and paving gravel were produced by Nielsons, Inc., and C. B. Johnson Gravel Products Co. State highway department crews produced paving gravel; contractors produced paving sand and gravel for the Federal Bureau of Public Roads. A small quantity of uranium ore produced at the Blue Eagle No. 1 by Elree Young was proc-

essed at the Shiprock (N. Mex.) mill where the contained vanadium also was recovered.

Montrose.—Production of uranium ore from 174 operations was 27 percent below that of 1962, when 198 operations were active. The county continued to lead the State in uranium ore output with 37 percent of the crude uranium ore, 42 percent of the contained uranium oxide, and 45 percent of the value of the crude ore at the mine. Principal producers were Union Carbide Nuclear Co., VCA, and Climax Uranium Co. The Mesa Creek mine operated by Union Carbide Nuclear Co. was the 1962 winner of the National Safety Competition award for metal mines. This was the 2d consecutive year that Union Carbide won the coveted honor for metal mines. In 1961 its Deremo mine in San Miguel County was the winner. Some marginal operations were closed; at others, developed reserves were exhausted and operations were terminated. The quantity of vanadium recovered from uranium ores declined 28 percent and paralleled the drop in uranium-ore production. Union Carbide Nuclear Co. operated its uranium-vanadium processing plant at Uravan. The Uravan plant was operated primarily for the recovery of uranium oxide. Vanadium contained in the uranium ores processed was shipped as a concentrate to the Rifle plant for final processing and recovery of the vanadium. VCA closed its uranium-vanadium concentrating plant at Naturita in March, when the plant at Durango was closed and operations transferred to Shiprock, N. Mex. The Naturita facility was maintained on standby in anticipation of processing high vanadium content ores.

Peabody Coal Co. acquired the Navajo strip mine from Edna Coal Co., renamed the mine Nucla, and continued the operation. Output used at the Colorado Ute Electric Association thermal powerplant at Nucla was 6 percent below that of 1962. Salt produced from well brines by Union Carbide Nuclear Co. was used at uranium processing mills at Uravan and Rifle. Montrose Concrete Products Co. produced building sand and building and fill gravel. State highway department crews produced paving gravel. Contractors produced paving gravel and crushed stone for the State highway department.

Natural gas production from the Montrose Dome field was 8 million cubic feet, a 47-percent drop compared with 1962 production. Output continued to decline, and at yearend the one well in the field had been plugged and abandoned.

Morgan.—Petroleum and natural gas production was from 267 oil wells and 7 gas wells in 51 fields. Petroleum and natural gas production was 39 percent below and 8 percent above, respectively, the production for 1962. Major producing fields were the Adena, Sand River, Zorichak, and Bijou. The very sharp 45-percent drop in output at the Adena field accounted for the decline in county output. Other older fields also declined in output; the number of new discoveries did not keep pace with production. At the Plainsman field, the only 1963 discovery to receive any development drilling, three new producers were completed and late in the year daily production from the field was nearly 200 barrels of oil. Oil well gas was processed at four plants. Associated Oil & Gas Co. operated the Bijou and Vallery plants, Natural Gas Producers, Inc., operated the Ft. Morgan plant, and Pure Oil Co. operated the Adena plant. Gas intake at the

four plants was 10 billion cubic feet of gas with the recovery of 971,000 barrels of natural gas liquids.

Building, paving, and fill sand and gravel were produced at five operations. Principal producers were Northwestern Engineering Co., Builders Aggregate Co., and Jacob Dorn & Son, Inc. Contractors produced paving gravel and crushed stone for the State highway department. Government crews produced paving and fill gravel for the State and county highway departments. The Great Western Sugar Co. produced quicklime for use at its Ft. Morgan sugar plant.

Ouray.—Production value of gold, silver, copper, lead, and zinc was 6 percent below that of 1962. Output was primarily from that portion of the Idarado mine lying in Ouray County, which was ranked second in the State in producing gold, copper, and lead, and third in silver and zinc. Actually, total output of the Idarado mine was greater than in 1962, and the drop in total county production, although slight, was caused by the closing of the Camp Bird mine in March. The mine and 600-ton-per-day mill were acquired by Federal Resources Corp. of Salt Lake City, Utah, in October; a program of exploration, development, and rehabilitation was begun. The primary target of the program was rehabilitation of the Revenue Tunnel and development of the Virginius vein to be mined through the tunnel. Plans also included resumption of mining through the Camp Bird Tunnel. The mine was idle most of the year except for limited production in January, February, and March. Seniorita Mining Co. operated the Seniorita mine, and Kuykendall Mines, Inc., operated the Wewissa. W. R. Nichols produced a small amount of copper ore. Paving gravel was produced by State highway department crews.

Park.—Value of mineral production increased threefold over that of 1962 largely because of increased output of sand and gravel and stone and the resumption of metal mining. Output of sand and gravel increased more than 28-fold over that of 1962. Domenic Leone Construction Co., Inc., produced paving gravel. State highway department crews produced paving sand and gravel. Contractors produced paving gravel and crushed stone for the State highway department. Harold E. Douglas and Carl Quist produced dimension sandstone (rough building). Robert Beal produced crushed sandstone for use in terrazzo, and Loyd Douglas produced crushed sandstone for use as an aggregate in precast slabs and shapes. George West produced crushed granite for use as an ornamental aggregate. Output of beryllium concentrate (beryl) by U.S. Beryllium Co. from the Boomer Lode mine was virtually the same as in 1962. The entire production was processed at the Mincon concentration plant at Lake George and the product shiped to the company plant at Loveland where high-purity beryllium oxide was recovered.

Uranium ore mined by Harding & Potter at the Lucky Jim mine and by the North Fork Mining & Manufacturing Co. at the Shawnee No. 1 was processed at the Cotter Corp. plant at Canon City. Placer gold was recovered at the Alma placer mine and at the Penn Hill placer mine by small-scale hand methods. Ores containing gold, silver, copper, lead, and zinc were produced by Triaqua Mining Co. at the Double Eagle mine, Robert G. McGhee at the Evening Star, Four Mile Mining Co. at the Hilltop, and Douglas Bros. Mining Co. at the Sweet Home. Peat was mined and used for soil conditioner. Individuals, mineral societies, and dealers collected a variety of mineral specimens.

747-416—64——18

Pitkin.—Output of bituminous coal at the Dutch Creek mine by Mid-Continent Coal & Coke Co. and at the Thompson Creek Nos. 1, 2, and 3 mines by Thompson Creek Coal & Coke Corp. was 20 percent above that of 1962. Three units for dewatering cleaned coal middlings and refuse were installed at the Dutch Creek mine, and a 100-ton-per-hour centrifugal dryer was installed at the Thompson Creek mines. Gravel for building, paving, fill, and other miscellaneous uses and sand for building and fill were produced by Chas. M. Evans, Hemann Sand and Gravel, and Whitewater Sand & Gravel Co. Paving gravel was produced by crews and contractors of the State highway department, and by contractors of the Federal Bureau of Public Roads and the Federal Forest Service. Output was more than double that of 1962.

Natural gas was produced at the 1-well Wolf Creek field. The well had been shut in since the initial production in 1961 following discovery of the field in 1960. Duane White produced a small quantity of lead-zinc ore at the Kerry Dee mine. Pitkin Iron Corp. had no activity at its deposit southeast of Ashcroft.

Pueblo.—Value of mineral production was nearly double that of 1962. The output value of all mineral commodities increased except that of clay which declined slightly. Major increases were in the value of sand and gravel and lime.

Building and paving sand and gravel was produced by five operators at seven locations. Major output was by Fountain Sand & Gravel Co. and Broderick & Gibbons, Inc. Fountain Sand & Gravel Co. also produced blast, engine, and filtration sand, and gravel for fill and miscellaneous uses. Paving gravel was produced by Government crews and contractors for the State and county highway departments for use in constructing Interstate Highway 25, including extensive interchange structures in the city of Pueblo and for county highways complementary to the Federal and State highway systems. Paving gravel for the Federal Forest Service was produced by contractors. Crushed and broken stone, also used on Interstate Highway 25, was produced by contractors for the State highway department. Production of quicklime by CF&I for use at its steel plant at Pueblo was 26,115 tons. This was the first full year of operation of the plant which was completed and began operation in August 1962. Crushed limestone for the plant was produced by the corporation at its Monarch quarry. Rate of output at the quarry was 1,400 tons daily in September. The corporation achieved what was believed to be a world record when its "F" blast furnace was closed down for relining in October. The furnace, in continuous operation for more than 9 years, had produced an estimated 2.6 million tons of pig iron. Longevity of the lining was attributed to improvements in furnace operation developed by the corporation staff. In 1957 natural gas was used for enrichment of the furnace blast, which was followed a year later with fuel-oil injection. Oxygen injection was begun in 1959, and more recently coal slurry was used. The furnace was the only one in the Nation that used natural gas, fuel-oil, oxygen, and coal slurry simultaneously for mix enrichment.

Fire clay was produced by Colorado Fire Clay Co., General Refractories Co., Harbison-Walker Refractories Co., and Red Mountain Clay Co. for manufacturing firebrick and block. Summit Pressed Brick & Tile Co. produced miscellaneous clay for manufacturing building

brick. Ores containing gold, silver, copper, lead, and zinc were recovered along railroad tracks, on sidings, and in railroad yards. The material was spillage from ore shipments made by rail. Metal content and value of the material was credited to the county because the county of origin was unknown.

Rio Blanco.—Petroleum output, 478 oil wells and 44 gas wells in 15 fields, was 1 percent below that of 1962; however, it represented 48 percent of the total production of petroleum in the State. Major production continued to be from the Rangely and Wilson Creek fields, which represented 99 percent of the county output. The Unita Refining Co. operated its 1,700-barrel-per-day refinery at Rangely. Throughput was 4 percent above that of 1962. Gasoline and other petroleum products were marketed locally and in the Denver area. Unit operations of the Rangely field Weber pool, by The California Oil Co., continued as planned. As of December 31, 134.5 million barrels of water had been injected into the reservoir through 98 injection wells; 86 percent of the water injected was from the White River. The White River water-treatment plant was completed and went into operation on May 29.

Natural gas production was principally from the Douglas Creek, Dragon Trail, and Piceance Creek fields. One new gasfield, South Douglas Creek, was discovered. Oil well gas from the Rangely (Weber) field was processed at the central stripping and satellite absorption plants by The California Oil Co. Throughput at the plants was 43.5 billion cubic feet of gas, with the recovery of 1.4 million barrels of natural gas liquids. The residual gas was injected into the pool to maintain bottomhole pressure and as plant and field fuel. A small part was flared.

Coal production by Jenkins & Mathis Coal Co. at the Rienau mine and by Staley-Gordon Coal Co., Inc., at the White River mine was 21 percent below that of 1962. Building sand and gravel was produced by Albert Kirkpatrick. Government crews and contractors produced paving gravel for the State highway department. Uranium ore produced at the Butterfly No. 1 and Midnight mines was processed at mills in Grand Junction and Rifle, where the contained vanadium also was recovered.

Routt.—Coal production from three underground and two strip mines was 62 percent above that of 1962. The increase was entirely from the Energy strip mine operated by Energy Coal Co. and the Edna strip mine operated by The Pittsburg & Midway Coal Mining Co. Both companies had long-term contracts with PSC to supply coal for thermal powerplants in the Denver area. Production from underground mines was by Dry Creek Coal Co. at the Cardinal, Hayden Coal Co. at the Babson, and Routt Mining Corp. at the Keystone.

Groundbreaking ceremonies at the $30.5 million Hayden powerplant, located halfway between Hayden and Steamboat Springs, were held on April 22. The plant being built by Colorado Ute Electric Association was the first 150-megawatt unit of a planned 4-unit installation. At the end of the year, the 250-foot smokestack was 70 percent complete, foundations were completed, and the 12-story generator building was virtually enclosed. Target date for beginning power generation was January 1965. The plant, a 9-month operation, was located on one of the most extensive coal fields in the State. Annual coal consumption was estimated to be 500,000 tons for the initial unit.

Petroleum production from 13 wells in 6 fields was 30 percent below that of 1962. Output dropped substantially at the North Sage Creek and Tow Creek fields. Government crews produced paving gravel, and contractors produced paving gravel and crushed stone for the State highway department. Contractors produced crushed basalt and paving gravel for the Federal Forest Service. McCoy Aggregate Co. produced scoria for use as a concrete aggregate and for railroad ballast.

Saguache.—Uranium ore shipped from the Erie mine by Pinnacle Exploration, Inc., was below that of 1962. The mine was shut down and placed on standby; shipments made from ores mined in 1962 were to fill allotments established at AEC. The ore was processed at the Cotter Corp. plant at Canon City. Graham Construction Co. produced gravel for building, paving, and miscellaneous uses. Government crews and contractors produced paving gravel and crushed stone for the State highway department. Individuals and mineralogical societies collected a variety of gem stones and mineral specimens. Turquoise was produced at the Villa Grove Turquoise Lode.

San Juan.—The value of mineral production was more than four times that of 1962, because of a full-year operation by Standard Metals Corp. at its Sunnyside group of mines and the Shenandoah concentrator. Output of the metals increased substantially: gold twofold, silver threefold, copper sixfold, lead and zinc threefold. Production came from the Sunnyside, Silver Lake, and Belle Creole mines. A long-term lease was obtained on the Brenneman mine, between the Sunnyside and Mogul mines, also controlled by Standard Metals Corp. The lease provided Standard Metals Corp. with a continuous vein system of 2.5 miles. Plans for extensive exploration and development of the Sunnyside, Belle Creole, and Spur vein systems were made. The Shenandoah concentrator processed ores from the Sunnyside, Belle Creole, and Silver Lake mines, as well as some custom ore. Late in the year, the mill was operated at a rate of 600 tons per day on a 5-day week basis, and studies were being made to increase mill capacity.

Silver Wing Mining Corp. began exploration and development work at the Silver Wing mine east of Silverton in Animas Canyon in October 1962. Copper ore produced late in 1962 and in 1963 was processed at the Pride of the West mill at Howardsville, which was under lease to the company. Concentrates were shipped to Magma Copper Co. at Superior, Ariz., and Inspiration Consolidated Copper Co., Inspiration, Ariz. Richardson Mines produced gold-silver ore at the Brooklyn mine, and Jake Morlang shipped material containing gold, silver, copper, lead, and zinc obtained through mill cleanup.

Individuals and dealers collected mineral specimens in the vicinity of Silverton and Gladstone.

San Miguel.—The value of mineral production was 3 percent above that of 1962. Gains in output value were recorded for gold, silver, lead, and zinc. There were minor declines in the value of output of copper, uranium ore, and vanadium. The county was ranked first in the output value of gold, copper, and lead and second in the State for silver, uranium ore, vanadium, and zinc. Gold, silver, and base-metal production was almost entirely from that part of the Idarado mine lying in San Miguel County. The entire output of the Idarado mine, in Ouray and San Miguel Counties, was milled at the Pandora

mill in Telluride. Shamrock Mining Co. produced a small quantity of gold-silver ore at the Shamrock mine. Uranium ore produced at 66 operations was 8 percent below that of 1962, when there were 72 operations. Major producers were Union Carbide Nuclear Co. and Dulaney Mining Co. The vanadium recovered from uranium ores processed at mills at Durango, Grand Junction, Uravan, and Rifle, and at Shiprock, N. Mex., was 4 percent below that of 1962. The decline was not exactly parallel to the reduction in uranium-ore production; ores with a higher vanadium content were mined and somewhat compensated the adjustment of operating schedules at uranium-processing plants to meet the 1962–66 program of uranium ore to procurement established by AEC.

Paving gravel was produced by Government crews and contractors for the State highway department and by contractors for the county highway department and the Federal Bureau of Reclamation. Brown iron ore (limonite) was mined by C. K. William & Co. Division, Chas. Pfizer & Co., Inc., at the Iron Springs Placer mine for use in manufacturing paint pigments. Theresa B. Robinson produced brown iron ore at the Iron Lode No. 3. Specimens of agate and dinosaur bones were collected by individuals. Crude petroleum was produced at the 1-well Lisbon-Southeast field, discovered in 1960. At yearend the well had been shut in.

Summit.—Value of mineral production was more than double that of 1962. Gains were recorded in the output and value of gold, silver, lead, and zinc; copper also was produced.

Major production of gold, silver, and the base metals was by the Wellington Mine Association at the Wellington mine in French Gulch east of Breckenridge. The 140-ton-per-day flotation mill that was moved to the Wellington from the Micawber mine at Crested Butte in the fall of 1962 began operating in February. Daily production was 140 tons. Other producers were Burke-Martin at the Albany mine, James P. Webb & Earl W. Knight, Jr., at the Boss, Robert E. Harper at the Chautauqua, Shoe Basin Mining Co. at the Shoe Basin, and R. J. & J. P. Webb at the Washington. Building and paving sand and building and fill gravel were produced by Giberson Sand & Gravel, Frisco, and J. S. Fulton Concrete, Dillon. Building and development of tourist attractions on the Blue River in the vicinity of the Dillon Dam continued at a slower pace than in 1962. Development of the Breckenridge winter-sports area also continued but at a lower rate as current projects were completed. Government crews produced paving sand and gravel for the State and county highway departments. Contractors produced paving gravel and crushed and broken stone for the State highway department and paving gravel for the Federal Forest Service. Mineral dealers collected specimens of ankerite near Montezuma.

Teller.—Mineral production in Teller County was limited to stone, sand and gravel, peat, and gem stones. Gold and silver output in 1962 was from the processing of ores mined in 1961 and cleanup of the Carlton mill following the closing of the plant on December 31, 1961. Although some examination and exploration work was done in selected areas, no metal-mining activity was reported in 1963.

Pikes Peak Granite Co. produced rough dimension granite for monuments. Wayne Bangert produced rough sandstone for building purposes. Peat production was used for soil conditioning and as an

admixture with organic fertilizers. Mineral societies, individuals, and dealers collected a variety of gem stones and mineral specimens in the vicinity of Crystal Peak, Florissant, and Cripple Creek.

Washington.—Petroleum and natural gas production from 391 oil wells and 4 gas wells in 71 fields was 20 and 39 percent, respectively, below that of 1962. Major petroleum output was from the Plum Bush Creek, Big Beaver, Bison, and Little Beaver fields. Gas production was from gas wells in the Little Beaver, Otis, and Surveyor Creek fields and oil well gas from oilfields. The county led the State in exploratory and development drilling. The most significant discovery was the Ranger field; eight successful development wells were completed and by the end of the year the field was producing 400 barrels of oil daily. At the Barefoot field, 7 miles west of the Ranger field, two successful development wells were completed, and at yearend the field was producing more than 100 barrels of oil per day. Oil-well gas was processed at the Little Beaver natural gas plant operated by Continental Oil Co. Throughput was 2 billion cubic feet of gas with the recovery of 458,000 barrels of natural gas liquids. Government crews produced paving gravel, and contractors produced paving gravel and crushed stone for the State highway department.

Weld.—Value of coal and petroleum represented 85 percent of the total value of county mineral production, which was virtually the same as in 1962. Coal output from six underground mines was 8 percent below that of 1962. Production was by The Imperial Coal Co. at its Eagle and Imperial mines, The Clayton Coal Co. at the Lincoln and Washington, Boulder Valley Coal Co. at the Boulder Valley, and McNeil Coal Corp. at the Sterling. Petroleum and natural gas production from 130 oil wells and 2 gas wells in 36 fields was 3 and 7 percent, respectively, above that of 1962. Petroleum output was principally from the Black Hollow, Pierce, and Southwest Roggen fields. Natural gas was from gas wells in the Riverside field and oil well gas from the oilfields. The Bounty field was discovered in April. An offset well was a failure. At the New Raymer field, discovered in 1960, four successful development wells were completed. One, an offset on the northwest edge of the field, found oil in the "D" sandstone which was a mile northwest of the nearest "J" sandstone production in the field. At yearend production from the seven wells (two in "D" sandstone and five in "J" sandstone) was averaging 350 barrels of oil per day. Oil-well gas was processed at the Roggen natural gas plant operated by McWood Corp. Throughput at the plant was 884 million cubic feet of gas, with the recovery of 55,000 barrels of natural gas liquids. Plants at the Battle Canyon and Roggen fields remained idle.

Building and paving sand and gravel and fill sand were produced by four operators. Major producers were Domenic Leone Construction Co., Inc., and Western Rock Products Co. Government crews produced building and paving gravel for the State and county highway departments and for the city of Greeley and crushed basalt for the county highway department. Contractors produced paving gravel and miscellaneous stone for the State highway department. The Great Western Sugar Co. produced quicklime for sugar refining at its plants at Eaton, Greeley, and Windsor. Specimens of barite were collected by the Colorado Mineral Society near Stoneham.

The Mineral Industry of Connecticut

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Connecticut Geological and Natural History Survey for collecting information on all minerals except fuels.

By James R. Kerr [1]

INCREASED stone production coupled with price increases for most stone products led the way in raising the value of Connecticut's mineral industry to a record high of $20.6 million. Value of sand and gravel, lime, clays, and scrap mica production also increased. Feldspar production remained virtually the same as in 1962, but a sharp reduction in the price of feldspar flotation concentrate dropped total value of production by more than 20 percent. Sand and gravel and stone production, chiefly for building and paving aggregate, responded to accelerated construction activity. Production of these commodities comprised 92 percent of the State's mineral wealth in 1963, compared with only 83 percent in 1953 and 43 percent in 1943. The termination of the Government strategic mineral purchase program for sheet mica and beryllium concentrates resulted in the closing of the mines producing these commodities. In terms of value, New Haven County was the leading mineral-producing area, followed by Hartford, Litchfield, Fairfield, and Middlesex, all with mineral values exceeding $1 million.

There was a continuing program of geologic mapping by the Geological and Natural History Survey of Connecticut in cooperation with the U.S. Geological Survey. A geologic quadrangle series was being published independently by the State.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

---

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

TABLE 1.—Mineral production in Connecticut [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate short tons	7	$4		
Clays do	178,942	287	189,344	$339
Gem stones	(2)	8	(2)	8
Lime short tons	35,180	635	35,262	666
Sand and gravel thousand short tons	10,208	9,244	10,503	9,343
Stone do	5,090	8,816	5,318	9,612
Value of items that cannot be disclosed: Feldspar, kaolin, mica (sheet and scrap), and peat		760		646
Total		19,754		20,614

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.

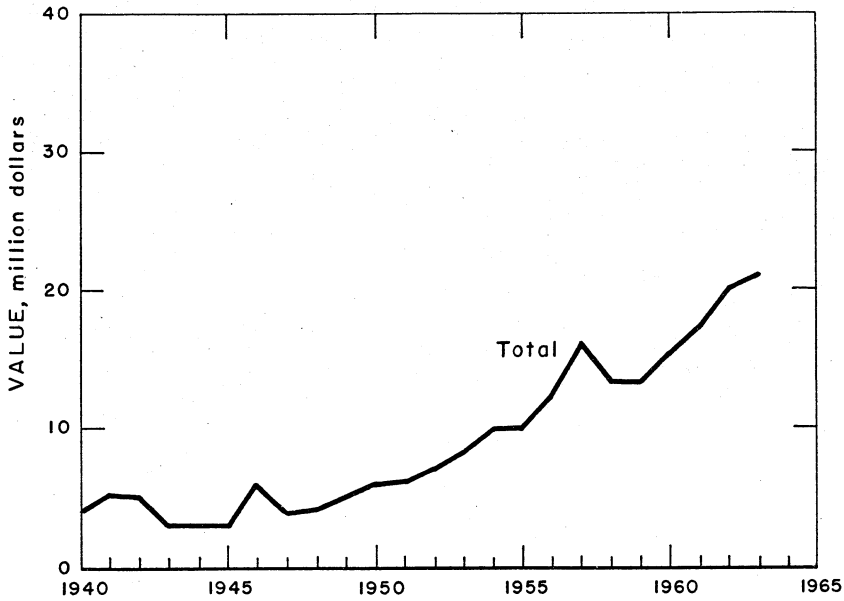


FIGURE 1.—Value of mineral production in Connecticut, 1940–63.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$7,891	1958	$13,245
1953	8,266	1959	12,738
1954	9,973	1960	15,243
1955	10,718	1961	16,601
1956	11,495	1962	19,817
1957	16,316	1963	20,657

Water.—The Bureau of Mines canvassed the mineral producers in 1963 for water usage in 1962. The production of large tonnages of washed sand and gravel required significant quantities of water, much of which was recirculated for reuse. The dimension and crushed stone and feldspar industries also used large quantities of water. A report was published [2] on water resources in the State.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Type of operation	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	86	198	284	70	16	9.79
Nonmetal mines and mills	480	----	480	451	29	436.85
Sand and gravel plants	1,708	512	2,220	1,584	124	184.82
Total	2,274	710	2,984	2,105	169	119.10

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Distribution terminals were operated at Middletown and Bridgeport. Marquette Cement Manufacturing Co. constructed a major distributing plant on the Connecticut River at Rocky Hill near Hartford. Cement for the three-silo plant will be transported from Catskill, N.Y., by the company's new oceangoing cement carrier. In addition Penn-Dixie Cement Corp. announced plans to construct a $200,000 cement distribution facility at Plainville.

Clays.—Production increased, chiefly because of a new market for clay as raw material for lightweight aggregate production. Plasticrete Corp. at Hamden began production of expanded clay aggregate at midyear. Production of miscellaneous clay for building brick and flowerpots was virtually the same as in 1962. The kaolin mine at Sharon Mountain was idle.

Feldspar.—Production remained virtually the same as in 1962 but values dropped sharply. Feldspar flotation concentrate, which supplied the glass and ceramic industries, has been produced in the State only since 1961, and prices were seeking their own levels. Production of crude feldspar, which supplies two long-established dry-grinding plants, continued at a stable rate, but one of the crude feldspar producers closed its quarry in 1963 and plans to purchase feldspar for grinding in the future.

Gem Stones.—Mineral collectors and amateur lapidarists collected various mineral specimens, chiefly from pegmatites in the western half of the State.

Gypsum.—Crude gypsum shipped from out of the State was calcined at a plant at New Haven to produce finished building products.

Mica.—Scrap mica, recovered as a byproduct of feldspar flotation, was processed at a plant in Middlesex County for use in roofing ma-

[2] Cushman, R. V., J. A. Baker, and R. L. Merkle. Records and Logs of Selected Wells and Test Boring and Chemical Analysis of Water in North-central Connecticut. 1963, 7 pp.

terials. Production was more than four times greater than in 1962. No strategic grade mica was produced in the State in 1963.

Sand and Gravel.—Despite a 13-percent decrease in production of commercial sand, the total production of sand and gravel in the State increased to a record 10.5 million tons. A 14-percent increase in output of commercial gravel and a 24-percent increase in production of Government-and-contractor paving gravel offset the loss in sand production. Production in Hartford County dropped 1.3 million tons, reflecting the completion of certain roadbuilding programs in that area. Building and paving uses consumed 86 percent of total commercial production of which 57 percent was sand (64 percent in 1962). Only 79 percent of total commercial output was processed, 6 percent less than in 1962. Average prices remained stable. Hartford County continued to lead in sand and gravel production, followed by New Haven, Fairfield, and Windham Counties. A survey of the sand and gravel resources of Connecticut was being made by the Connecticut Highway Department.

TABLE 4.—Sand and gravel sold or used by producers, by classes of operations and uses

Class of operation and use	1962		1963	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Molding	1,625	$1,948	(1)	(1)
Structural	2,537,070	2,670,376	2,145,018	$2,283,593
Paving	1,969,256	1,880,813	1,835,901	1,726,474
Fill	394,614	248,926	174,089	78,396
Other [2]	143,644	129,115	225,209	162,739
Total	5,046,209	4,931,178	4,380,217	4,251,202
Gravel:				
Structural	1,245,535	1,854,671	1,389,119	2,192,631
Paving	1,039,840	1,096,014	1,161,623	1,175,269
Fill	414,692	274,004	540,656	273,371
Miscellaneous	133,764	110,417	109,351	110,024
Other	22,363	16,688	50,996	61,862
Total	2,856,194	3,351,794	3,251,745	3,813,157
Total sand and gravel	7,902,403	8,282,792	7,631,962	8,064,359
Government-and-contractor operations:				
Sand:				
Paving	86,975	33,950	110,683	41,100
Fill	1,400	490	----------	----------
Other	24,534	12,952	30,830	16,029
Total	112,909	47,392	141,513	57,129
Gravel:				
Building	----------	----------	675	250
Paving	2,189,573	912,109	2,705,244	1,210,645
Other	3,523	1,233	[3] 23,490	[3] 10,192
Total	2,193,096	913,342	2,729,409	1,221,087
Total sand and gravel	2,306,005	960,734	2,870,922	1,278,216
All operations:				
Sand	5,159,118	4,978,570	4,521,730	4,308,331
Gravel	5,049,290	4,265,136	5,981,154	5,034,244
Total	10,208,408	9,243,706	10,502,884	9,342,575

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes filter, other sand, and items indicated by footnote 1.
[3] Includes fill gravel.

Stone.—Value of stone production increased 9 percent. Basalt continued to be the leading type of stone produced, comprising 92 percent of total tonnage and 80 percent of value. Most of the crushed basalt production was for concrete aggregate and roadstone. Limestone, the second ranking stone, was quarried only in Litchfield County, and was used chiefly as agricultural stone (agstone) and for lime manufacture. New London County led in production of crushed granite, which was mostly used for concrete aggregate, and New Haven County led in production of dimension granite. Quartzite was quarried and crushed in New London County for sale mainly to the glass industry. Quartz recovered as a byproduct in feldspar flotation also was sold for glass manufacture. Production of dimension sandstone was reported in Windham County for the first time in recent years. Dimension stone (gneiss) was quarried in Tolland County.

TABLE 5.—Stone sold or used by producers, by uses

Use	1962		1963	
	Short tons	Value	Short tons	Value
Dimension stone	10,350	$217,828	13,846	$171,074
Crushed and broken stone:				
Agstone	69,512	301,126	80,985	378,821
Concrete, roadstone	4,711,134	7,136,706	4,937,179	7,861,882
Riprap	74,210	114,070	(1)	(1)
Undistributed [2]	225,119	1,046,525	286,327	1,200,413
Total	5,090,325	8,816,255	5,318,337	9,612,190

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes flux, ground quartz, railroad ballast, riprap, and other stone.

MINERAL FUELS

Coke.—Merchant coke was produced at a plant at New Haven that operated 70 slot-type ovens. In addition, coal chemical materials, including ammonium sulfate, coal tar, crude light oil, and intermediate light oil, were recovered.

Peat.—Output of peat from a bog in Middlesex County was less than half that of 1962. Production was sold in bulk for soil conditioning uses.

METALS

Active research programs and expanded and improved production facilities characterized the State's metal industries, particularly the nonferrous metal industry. Research was directed mostly to developing new products and techniques. Examples were the development of a seamless tubing of rhenium and molybdenum, the first of its type, using powder metallurgy. This product, characterized by excellent weldability and ductility after high-temperature exposure, was developed by Chase Brass & Copper Co., a subsidiary of Kennecott Copper Corp. This company also installed a new, extremely high temperature sintering furnace to increase capacity for, and improve quality of, rhenium-tungsten alloys. These alloys are used for critical components in electronic, nuclear, and space applications.

New and expanded uses for calcium metal, particularly as a reducing agent in metallurgy, were the aim of a promotional campaign by Chas. Pfizer & Co., Inc. through its affiliate New England Lime Co., sole domestic producer of calcium metal. Plans were announced for the development of a center for metallurgy and materials sciences at the University of Connecticut. Carpenter Steel of New England, Inc., continued operation of two electric furnaces at Bridgeport, and numerous foundries in the State produced castings from ferrous and nonferrous metals.

REVIEW BY COUNTIES

Sand and gravel produced under contract for the Connecticut State Highway Department was not attributed to specific counties. In addition, certain municipalities produced sand and gravel for use in road maintenance. Most of the Government-and-contractor production was for road construction and maintenance, and some was used for sanding icy highways.

TABLE 6.—Value of mineral production in Connecticut, by counties

County	1962	1963	Minerals produced in 1963 in order of value
Fairfield	$1,244,391	$1,257,899	Sand and gravel, gem stones.
Hartford	7,245,314	5,977.865	Sand and gravel, stone, clays.
Litchfield	2,218,713	2,436,376	Stone, lime, sand and gravel, gem stones.
Middlesex	1,156,343	1,225,523	Stone, feldspar, sand and gravel, clays, mica, peat.
New Haven	5,219,840	5,990,049	Stone, sand and gravel, clays.
New London	883,560	980,371	Stone, sand and gravel.
Tolland	183,990	187,237	Sand and gravel, stone.
Windham	(1)	(1)	Do.
Undistributed [2]	1,602,210	2,558,687	
Total	19,754,000	20,614,000	

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes sand and gravel and gem stones that cannot be assigned to specific counties, and values indicated by footnote 1.

Fairfield.—Production of sand and gravel decreased 10 percent, but total value increased slightly because the average value per ton increased by $0.16 to $1.43. This was caused by a 29-percent increase in production of higher valued building sand. Output of paving sand and gravel decreased more than 80,000 tons. Twelve operations were active, producing mostly building and paving sand and gravel. The leading producers were John Lamazzo & Sons Corp., Weston; The Grasso Construction Co., Shelton; Daddario Sand & Gravel, Newton; The Bernard J. Dolan Co., Bethel; and Lambert, Inc., Brookfield Center. Mineral specimens collected near Trumbull included topaz, scheelite, and wolframite.

Hartford.—Because of a 39-percent decrease in value of sand and gravel production, the county fell from first to second ranking among the state's mineral-producing counties. Clay production increased significantly, and value of stone production was slightly higher. Stone replaced sand and gravel as the county's leading mineral commodity. Basalt was the principal stone produced; output of dimension granite was small. Most of the crushed basalt was sold

for concrete aggregate and roadstone; a small tonnage was marketed as riprap and railroad ballast. The leading producer was The Edward Balf Co., Newington. Other producers were Roncari Industries, Inc., successor to Materials Service, Inc., at East Granby; The New Haven Trap Rock Co., Plainville; Sherman Tomasso Concrete, Inc., with two quarries near Plainville; and Arborio & Sons, Inc., Farmington. Sherman Tomasso announced plans to construct a central ready-mixed concrete plant at its Plainville quarry. A price increase for crushed basalt was put into effect. Dimension granite was quarried near Glastonbury by Tower Hill Granite Co. for dressed construction uses.

Combined production of building and paving sand plummeted to less than half that of 1962. Production of gravel, however, was virtually the same as in 1962; the loss was in fine aggregate, rather than in the total aggregate market, and was due to the completion of certain roadbuilding programs. Production of fill sand and gravel increased because new roadbuilding was initiated. Sand and gravel production was centered in the Hartford area. Leading among the 25 producers were The Edward Balf, Co., Glastonbury; Costello Construction Corp. with plants at Newington and Bloomfield; Connecticut Sand & Stone Corp., Plainville; Dunning Sand & Gravel Co., Inc., Farmington; and Roncari Industries, Inc., East Granby. Over 65 percent of the sand and gravel output was washed, sized, screened, or otherwise prepared. The county continued to rank first in the State in sand and gravel production with output of more than 2.8 million tons.

Miscellaneous clay for building brick was produced by Kelsey Ferguson Brick Co., Suffield, and the Carpenter Brick & Clay Products Corp., South Windsor. The latter company sold part of its ouptut to Plasticrete Corp., also of South Windsor, for expanded clay lightweight aggregate production. The Keller Pottery Co. produced miscellaneous clay for making flowerpots. Donnely Brick Co. closed its operation in December 1962, and Edward W. Mack & Son did not operate its clay mine in 1963.

Litchfield.—Stone, the leading commodity, was produced at four limestone and one basalt quarries. Limestone production increased 8 percent. New England Lime Co., Division of Chas. Pfizer & Co., Inc. (Canaan), was the leading producer; output was for captive lime production and for sale as filler in tile and rubber. Other limestone producers were The Conklin Limestone Co., Inc. (Canaan), producing agstone; U.S. Gypsum Co. (Falls Village), producing chiefly agstone and fillers; and the Allyndale Corp. (East Canaan), a new producer with output of agstone. Building Materials, Inc., quarried basalt at Woodbury, chiefly for concrete aggregate.

Most of the lime produced by New England Lime Co. at Canaan was consumed by Nelco Metals at a nearby plant in manufacturing high-purity calcium and magnesium. The remainder was consumed in construction and as agstone.

Sand and gravel production increased 14 percent. The greater portion of the increased output was attributed to increased production of paving gravel. About 80 percent of the total output was processed. Uses included building (50 percent), paving (35 percent), and miscellaneous. Output was reported by 9 producers at 10 plants.

The larger were Sega Sand & Gravel Co., Inc., New Milford; Connecticut Sand & Stone Corp. with two operations at Canaan; and Building Materials, Inc., Torrington. The latter company announced plans to build a $100,000 asphalt plant in Harwinton early in 1964.

The Sharon Mountain kaolin pit of Carpenter Brick & Clay Products Corp. was idle. There was no activity in the beryl industry. Mineral specimens collected included calcite, anatase, rutile, and zeolite.

Middlesex.—Feldspar output remained relatively stable, but value of production decreased 22 percent because prices of The Feldspar Corp.'s production were lower. This company, the leading producer, mined and processed crude feldspar at Middletown. Beneficiation by flotation prepared the material for sale to the glass and ceramic industries. In addition, the company recovered scrap mica and quartz as coproducts. The mica was processed by dry grinding by Deneen Mica Co. of Connecticut, also at Middletown, for use as roofing material. The quartz was sold for glass manufacture. Feldspar also was mined and processed by Eureka Feldspar Mining & Milling Co., Portland, for ceramics, and by Worth Spar Co., Inc., at Cobalt, for soaps and abrasives. The latter company closed its feldspar quarry and plans to buy its requirements in the future.

Production of sand and gravel almost doubled. Six pits were active, one more than in 1962. All major markets shared in the increased output, but the paving aggregate market expanded most, consuming over half the total output. About 90 percent of sand and and gravel production was washed, screened, or otherwise prepared. Shore Line Washed Sand & Stone Co., Inc., at Madison, was the leading producer. Shoreline Concrete Co., Inc., took over the operation of Bugg & Heser and produced sand and gravel for ready-mixed concrete aggregate.

The Michael Kane Brick Co. mined miscellaneous clay and produced building brick near Middletown. Production of reed-sedge peat was reported by Cedar Swamp Peat Co. from its bog near Saybrook. Output was less than in 1962. The termination of the Government strategic minerals purchase program for sheet mica and beryl resulted in the closing of Tollgate mine near Middletown, the Victoria and Worth Spar mines near East Hampton, and the Andrews quarry near Portland.

New Haven.—Increased production of stone and sand and gravel elevated the county to first rank in the State in total value of mineral production. Basalt, the leading stone, was produced chiefly for concrete aggregate and roadstone by four operators at five quarries. The leading producer was The New Haven Trap Rock Co. from quarries near Wallingford and North Bramford. This company opened a new asphalt mix plant in Stonington capable of producing 3 tons of asphalt mix every 40 seconds. Other producers were The York Hill Traprock Co., Meriden; Charles W. Blakeslee & Sons, Inc.; and A. N. Farnham, Inc. Barclay Quarries was idle. Dimension granite for rough architectural use was quarried by Castellucia & Sons, Inc., at Stoney Creek near Bramford.

Sand and gravel production increased 11 percent to total more than 1.5 million tons. The greatest increase was in output of building sand, which rose 43 percent. The major market for sand and gravel in the county was the building construction industry, which consumed 66 percent of total output. Of the 13 operating companies producing at 15 plants, the larger were Cinque Brothers Co. and Guilford Sand and Gravel Co. with pits at Northford and Guilford; Waterbury Sand and Gravel, Inc., Waterbury; estate of Stillman H. Rice, New Haven; Meriden-Wallingford Sand & Stone Co., Inc., Wallingford; and The D. J. Carten Sand & Gravel Co., Devon. Over three-fourths of the county output was washed material.

The Stiles Brick Corp. reported production of miscellaneous clay for building brick from its pit near North Haven. The termination of the Government strategic minerals purchase program for sheet mica and beryl resulted in the closing of the Benson mine, Southbury, and Southford quarry, Southford.

New London.—Increased production of crushed quartzite was reported by Connecticut Silica Co. from its quarry at North Stonington. The larger portion of output was for glass manufacture. Other uses included abrasives, foundry sand, roofing granules, and exposed highway aggregates. Barrett Division, Allied Chemical Corp. produced crushed granite near Montville for use primarily as concrete aggregate and roadstone. Dimension granite for rough monumental stone was quarried by Golden Pink Granite Quarry at East Lyme. Millstone Granite Quarry, Inc., Waterford, went out of business in 1963. A small tonnage of miscellaneous stone was quarried near Old Lyme.

Significantly increased output of building gravel offset production losses of paving sand and gravel and resulted in an overall increase of county output. Production of fill and other gravel also increased. Leading producers were John J. Doyle Sand & Gravel Co., Inc., Montville; Lavoie Brothers, Inc., Waterford; Machnik Bros., Inc., Montville; and The Westerly Ready-Mixed Concrete Co., Pawcatuck. Over 83 percent of county output was processed material.

Tolland.—Sand and gravel production was 17 percent greater, but a price reduction of $0.09 per ton kept total value of output at a rate similar to that of 1962. Production of fill gravel was over four times that of 1962, reflecting preliminary stages of roadbuilding. Production of building sand also increased, being nearly three times greater than in 1962. Production was reported by Philip Chapman and E. Foster Hyde, both at Ellington, and Myron M. Lee, Andover. Miscellaneous stone (gneiss) was quarried by Skyline Quarry near Crystal Lake and sold as a building stone and for rubble.

Windham.—A 44-percent increase in output of paving sand and gravel offset a loss in production of sand and gravel for building aggregate, and caused a 7-percent increase in total county output. Dunning Sand & Stone Co., Inc., Wauregan, was the leading producer. Other operations were those of R. A. Rawson Sand & Gravel, Putnam; Ernest Joly & Sons, Danielson; and Miller Brothers, Willimantic. Knox Glass Co. planned an increase in capacity and storage facilities at its Danielson operation, which could result in an employment increase of 200 persons.

Dunning Sand & Stone Co., Inc., which had produced significant quantities of crushed basalt from boulders recovered at its sand and gravel pit in 1962, concentrated more on sand and gravel in 1963, and output of crushed basalt was only about one-third that of 1962. Two new sandstone quarries operated by Helene Stone Corp., Sterling, and Arthur L. Hughes, Kellingly, produced dimension sandstone, chiefly for use as rough-cut building facing. R. B. Marriott & Sons quarried dimension granite near Oneco for curbing and rubble.

The Mineral Industry of Delaware

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Delaware Geological Survey for collecting information on all minerals except fuels.

By Samuel A. Gustavson [1]

MINERAL production for Delaware in 1963 was valued at $1.3 million, about 12 percent less than in 1962. Lower demand for gravel fill and subsurface road work during the 1963 phase of highway construction, especially through marshy areas south of Wilmington, accounted for this decrease. Gravel production was slightly less than 600,000 tons in 1963, compared with 1.3 million tons in 1962. Production and value of sand, crushed granite, and clay increased over those of 1962.

The most developed natural resource in the State is sand and gravel, of which large quantities are available. Use is primarily for highway construction and as a concrete aggregate. A number of deposits of stone in the State could meet specifications for highway or aggregate use. However, only granite (gabbro) from the Shellpot quarry in New Castle County is currently being produced. Output in the form of riprap and crushed stone was greater than in 1962. Miscellaneous clay was produced from a pit in New Castle County for manufacturing common brick. Output was over 20 percent greater than in 1962. Some mineral specimens were collected.

TABLE 1.—Mineral production in Delaware [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays.....thousand short tons..	(2)	(2)	13	$13
Sand and gravel.....do....	1,755	$1,445	1,094	1,136
Value of items that cannot be disclosed: Gem stones, stone, and values indicated by footnote 2.....	.....	86	.....	192
Total.....	.....	1,531	.....	1,341

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company data.

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957-59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$747	1958	$1,152
1953	686	1959	1,255
1954	984	1960	982
1955	1,701	1961	1,055
1956	1,205	1962	1,542
1957	1,059	1963	1,347

Employment.—Mineral producers worked an average of 95 men per day for the year, totaling 175,000 man-hours. About 102,000 man-hours was in pits and quarries, 52,000 man-hours in processing and transporting material, and 21,000 man-hours for supervision and office work. Two lost-time injuries were reported. This compared with 220,000 man-hours worked and 10 lost-time injuries in 1962.

Water.—The Bureau of Mines canvassed mineral producers in 1963 for water usage in 1962. Table 3 gives a preliminary summary of the data reported. In Delaware water use was limited to washing, sizing, and otherwise preparing sand and gravel for use on highways and as an aggregate in concrete. Water used was not treated. Consumption represents estimates of evaporation loss during washing and water contained in the product. Most of the water used was returned to the stream or ground water system through settling ponds.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Commodity	New water	Water recirculated	Total water use	Water discharged	Water consumed	Gallons of new water per dollar value of production
Clays	(1)					
Stone	(1)					
Sand and gravel	112	41	153	106	7	73.46
Total	112	41	153	106	7	73.46

[1] Less than 1 million gallons per year.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—Common building brick was manufactured from miscellaneous clay produced by the Delaware Brick Co. from an open-pit mine near New Castle. No sales of crude clay were reported.

Gem stones.—A variety of mineral specimens were collected by individuals and members of mineral clubs. Sources were the seashore and rock outcrops.

Sand and Gravel.—The principal mineral produced in Delaware continued to be sand and gravel. Sand was used chiefly for building and highway construction, each consuming over 220,000 tons. Sand also was used as fill, for engine traction, and to rebuild swimming beaches along the ocean shore. Production was about 12 percent greater than in 1962, but the average value of sand sold, about $0.95 per ton, was about $0.02 less. Most of the gravel produced was used in highway construction (road base and surface, bridges, etc., excluding fill). In terms of tonnage, use in building construction was second, and fill and miscellaneous uses consumed relatively minor quantities of gravel. The tonnage of gravel used as road base was much less than in 1962, owing to the phase of construction rather than a decline in construction activity. This accounted for the 55-percent drop in output of gravel. The drop in use of this normally lower-priced material is reflected in the increase in average unit value of gravel from $0.77 per ton in 1962 to $1.11 in 1963. Fifteen sand and gravel operations were active, compared with 14 in 1962. Virtually all the sand and gravel was shipped by truck; only a few thousand tons were transported by rail. Of the total sand and gravel produced, 679,000 tons was processed and 415,000 tons was unprocessed.

Stone.—One operator reported production of stone in the State. Petrillo Bros., Inc., operated the Shellpot quarry, a gabbro deposit classified as granite for statistical purposes. Output was considerably greater than in 1962. Some tonnage was sold as riprap, but most of the production was crushed for use in building and highway construction and as stone sand. The Delaware State Highway Department purchased stone. In addition to State sources, crushed basalt was purchased from quarries in Pennsylvania and Maryland, and crushed limestone was purchased from a quarry in Pennsylvania.

REVIEW BY COUNTIES

Kent.—Sand and gravel was the only mineral commodity produced. Sand production increased, and gravel output was about the same as in 1962. Producers included St. Jones River Gravel Co. at Dover, Clough & Caulk Sand & Gravel at Wyoming, M. A. Hartnett, Inc., at Dover, and Barber Sand & Gravel at Harrington. Virtually all the material was used in building or highway construction. No production was reported by Fisher Carpenter at Milford.

New Castle.—Minerals produced included clays, stone, and sand and gravel. Sand production was a little over 200,000 tons, virtually unchanged from 1962. Gravel production, however, was only slightly over 500,000 tons, a 58-percent decline from 1962. Need for large tonnages of material for construction of highways through marsh areas was less in 1963 than in the 2 previous years. Producers of sand and gravel in the county included Delaware Sand & Gravel Co., Freeway Sand & Gravel Co., and Parkway Sand & Gravel, Inc., all near New Castle; Whittington Sand & Gravel Co. at Bear; John C. Green, Jr., at Middletown; and Petrillo Bros., Inc., at Wilmington. The Freeway Sand & Gravel Co. merged with Parkway Gravel, Inc., as of December 31, 1963. Petrillo Bros., Inc., also produced riprap and crushed granite (gabbro) from the company's Shellpot quarry near Wilmington. Building brick was produced by Delaware Brick Co. from miscellaneous clay mined at an open pit near New Castle.

Sussex.—Lewes Sand Co. at Lewes produced bank run engine sand. Sand and gravel for construction use was produced by Atkins Brothers at Millsboro and Henry G. Graves & Sons, Inc., at Georgetown. Total output was virtually the same as in 1962.

The Mineral Industry of Florida

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Florida for collecting information on all minerals except fuels.

By Lawrence E. Shirley [1] and William D. Reves [2]

PRODUCTION of mineral commodities increased 8 percent over 1962, establishing a record year for the State. Total value of mineral production was $202 million, compared with $186 million in 1962. The increase in value was due primarily to a 5-percent increase in marketable production of phosphate rock, a 17-percent increase in total stone output, a 27-percent increase in sand and gravel, a 23-percent increase in primary lime, a 10-percent increase in total clay, and minor increases in other commodities.

Florida, for the 70th consecutive year, continued to lead the Nation in phosphate rock production and, for the 24th consecutive year, led the Nation in zircon output. The State, for the 6th consecutive year, led the Nation in fuller's earth production and was the only producer of staurolite in the United States.

Other commodities showing increases over 1962 outputs were portland cement, ilmenite, rutile, zircon, crude petroleum, natural gas and peat. Commodities that decreased below 1962 outputs were masonry cement, magnesium compounds, and rare-earth concentrates.

The three leading companies in value of mineral production were International Minerals & Chemical Corp., V-C Corp. and General Portland Cement Co.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar by the appropriate group implicit price deflator.

Consumption, Trade, and Markets.—Consumption of mineral commodities continued at a high rate during the year. Construction activity increased considerably, reflecting upward demand for mineral commodities such as portland cement, crushed stone, and sand and gravel for use in roads, buildings, and other new facilities.

---

[1] Mining engineer, Area II Mineral Resource Office, Bureau of Mines, Knoxville, Tenn.
[2] Geologist, Florida Geological Survey, Tallahassee, Fla.

TABLE 1.—Mineral production in Florida [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	487	$6,741	538	$7,777
Gem stones			[2]	[3]
Lime—thousand short tons	[4]	[4]	126	1,996
Natural gas—million cubic feet	29	6	35	7
Peat	20,595	139	21,049	129
Petroleum (crude)—thousand 42-gallon barrels	419	[4]	[5] 464	[4]
Phosphate rock—thousand long tons	13,949	94,595	14,592	101,050
Sand and gravel—thousand short tons	5,924	5,179	7,542	5,823
Stone—do	27,279	32,608	31,900	38,173
Value of items that cannot be disclosed: Cement, magnesium compounds, natural gas liquids, rare-earth metal concentrates, staurolite, titanium concentrates, zirconium concentrates, and values indicated by footnote 4		[6] 46,432		46,665
Total		[6] 185,700		201,620

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Less than $500.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Preliminary figure.
[6] Revised figure.

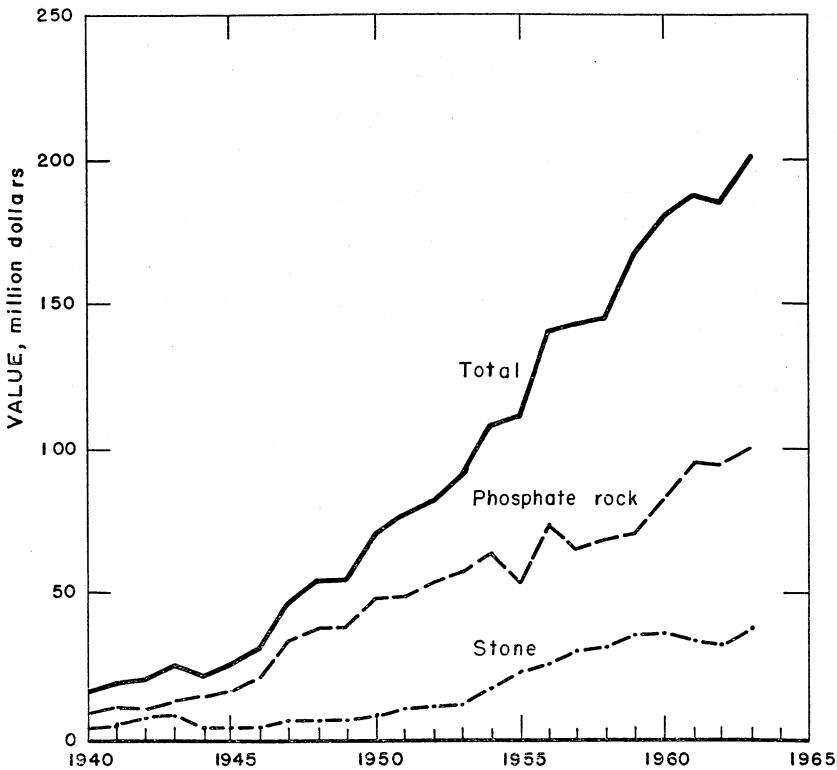


FIGURE 1.—Value of phosphate rock, stone, and total value of mineral production, 1940–63.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$94,442	1958	$145,989
1953	101,452	1959	166,311
1954	113,847	1960	180,228
1955	115,324	1961	191,387
1956	141,692	1962	185,282
1957	139,193	1963	198,592

Trade through Florida ports in mineral commodities showed increases in both imports and exports. Exports included phosphate rock and related products, lithium ore, sand for glassmaking, clays, crushed limestone, titanium concentrates, rare-earth concentrates, and staurolite; imports included cement, crude molten sulfur, crude gypsum, refined lead, marble, and other commodities.

During the year the Port of Tampa acquired a 53-acre addition by purchasing the Tampa Naval Industrial Reserve, Hooker's Point, including 63 buildings, 2,600 feet of waterfront, 4 shipways, roads, rail tracks and many other installations; this acquisition will provide increased capability for cargo handling and other port activities.

Gypsum, perlite, and vermiculite were brought in from other States and foreign sources and processed for consumption in Florida and marketing areas in nearby States. Late in the year, Kaiser Gypsum Co. started construction of a $6.5 million gypsum products plant on the 34-acre site near Jacksonville. The new plant will have an annual capacity of 180 million square feet of gypsum board products and 40,000 tons of plaster. Gypsum ore will be brought in from Cape Breton Island, Nova Scotia, and processed for distribution throughout the Southeastern States. Other gypsum plants in the State, also using Nova Scotia ore, are United States Gypsum Co., also of Jacksonville, and National Gypsum Co., Tampa. Vermiculite was shipped from other States and processed by four plants for use in building products, soil conditioning, and other uses. Crude perlite, brought in from Western States, was processed by three plants for distribution in the State and nearby Southeastern marketing areas.

Phosphate rock exports from the Ports of Tampa and Boca Grande increased slightly over 1962; value-wise this commodity continued to lead in mineral commodity exports from the State, and excellent bulk-handling facilities exist at the two ports.

Trends and Developments.—New producers, reporting mineral production for the first year, increased during 1963. Eleven new crushed limestone quarries, eight sand and gravel mines, and one new clay operation reported output for the first time. Total crushed limestone and sand and gravel output increased 16 and 27 percent, respectively, over that of 1962, establishing alltime high records. The increases were due to accelerated construction of highways, bridges, buildings, and related activities.

One of the leading indicators of industrial growth, electric power, continued to expand at a rapid rate throughout the State. Tampa Electric Co., stepped up capacity to 1,184,000 kw during the year and spent $24 million in capital improvements, bringing its total plant

investment to $224 million. Plans for the next 5 years call for additional investment of an estimated $105 million. Gulf Power Co.'s new station at Panama City was under construction and is expected to consume 325,000 tons of coal per year when it goes into operation in 1965. The first unit will have a capability of 146,000 kw.

Road and bridge construction continued to increase during 1963. New expansion programs to cope with heavy traffic demands were announced by the State highway department, Jacksonville Expressway Authority, and County highway departments. Interstate road construction continued and much progress was made during the year. The 155 mile Florida Turnpike extension connecting with Interstate 75 at Wildwood was nearing completion at yearend; the entire extension, from Fort Pierce to Wildwood, near Ocala, will require 4.7 million square yards of limerock base.

Growth of the phosphate industry in Florida and the trend toward use of liquid sulfur to make the sulfuric acid necessary for processing the rock has prompted the establishment of new terminals in Florida. In 1963, there were four liquid sulfur terminals in Tampa with a total storage capacity of 87,500 long tons and one terminal in Jacksonville with a capacity of 11,000 long tons. Delivery of liquid sulfur to terminals requires the construction of special ships to handle the molten material. Texas Gulf Sulphur Co. announced that a new ship, the Marine Texan, was under construction with a capacity of 23,000 long tons of liquid sulfur which will transport the molten material from Texas Gulf's main terminal at Beaumont to regional terminals at Tampa and to six east coast ports. The new ship will be 614 feet long and will cruise at 14½ knots and will replace the Marine Sulphur Queen which was mysteriously lost at sea in February.

Legislation and Government Programs.—The 1963 Florida Legislature enacted water resources laws pertaining to general, regional, and local applicability. Laws of general applicability were principally amendments to previous laws and revision of the basic statute. Laws enacted of regional applicability pertained to (1) the establishment of a Southeast River Basins Resource Advisory Board, which makes it possible for Florida to join with other southeast river basin States to continue the coordination engendered by the U.S. Study Commission in the program of water resources development; (2) creation of the Holmes Valley Authority, comprised of all of Jackson, Holmes, Walton, and Washington Counties, to improve the navigability of the Choctawhatchee River and Holmes Creek; and (3) laws increasing penalties for pollution of the Alafia and Peace Rivers. Laws of local applicability pertained to county drainage districts of interest principally to those individual counties.

A contract was awarded about midyear, by the Office of Saline Water, U.S. Department of the Interior, for a detailed engineering and financial feasibility study of a combination thermal-electric and sea water desalting plant to be located in the Florida Keys, near Key West. The study was being conducted in cooperation with the Florida Keys Aqueduct Commission, the City of Key West, and certain REA cooperatives. Key West and other Florida Key communities have had acute water supply problems for many years. Fresh water has

been obtained from wells on the Florida mainland by a 140-mile pipeline which cannot meet the growing needs.

Water.—During 1963 the Bureau of Mines conducted a water canvass of the entire mineral industry of the United States for the year 1962. The results of that canvass pertaining to the State of Florida are shown in table 3. Total water use in the State was 254 billion gallons; of that amount 30 percent was new water used and the remaining 70 percent was recirculated water. The largest user of water was nonmetal mines and mills which consumed 88 percent of the total water used in the State.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Industry	New water	Recirculated water	Total water use
Quarries and mills	8,188	3,672	11,860
Metal mines and mills	5,699	11,380	17,079
Nonmetal mines and mills	60,983	162,911	223,894
Sand and gravel mines	537	1,168	1,705
Total	75,407	179,131	254,538

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Total cement output, including masonry and portland, increased slightly compared with that of 1962. Masonry cement, continuing a decline begun in 1960, decreased 5 percent in output and 7 percent in value. Portland cement increased 2 percent in output but decreased 2 percent in value.

General Portland Cement Co. operated two plants in the State, one at Miami and the other at Tampa. The two plants, making up the Florida division of the company, produced 33 percent of the total cement capacity of the overall organization. Demand for cement in Florida has increased much more than in the Nation generally in the past 10 years, according to the company. Because the plants can be operated on a year-round basis, capital investments in the company's Florida plants can be more fully utilized than they would be in locations where construction and cement usage are to some extent curtailed by severe weather.

Lehigh Cement Co. operated plants near Miami and at Bunnell in Flagler County.

In October, United States Steel Co.'s Universal Atlas Cement Division opened its new Jacksonville cement distribution facility. The new station is a complex of six 148-foot-high bulk cement storage silos with a total annual capacity of 32,000 tons of cement; a packhouse combining storage area for packaged cement and offices; fully mechanized bulk and package loading operation; concrete roadways and parking areas; railroad track; and four pipelines for transporting cement from the Commodores Point Terminal dock where self-unloading bulk cement cargo ships will be moored. The new station

is situated and designed to serve the growing market for cement products throughout north Florida and southeast Georgia.

Imports of cement through the Florida Customs District were 314,000 barrels (376-pound), compared with 365,000 barrels in 1962.

Clays.—Total clay production, including fuller's earth, kaolin, and miscellaneous clay, increased 10 percent in tonnage and 15 percent in value, compared to decreases of 5 percent in tonnage and 6 percent in value in 1962. For the 6th consecutive year, Florida ranked first in the Nation in production of fuller's earth and established a record year in both output and value.

Fuller's earth was mined in Gadsden County by Minerals & Chemicals Philipp Corp., Floridin Co. Inc., and Magnet Cove Barium Corp., listed in order of output. Production came from five mines operated by these three companies and output and value increased considerably over the previous year.

Kaolin output and value increased over 1962; production came from two mines in Putnam County. .Edgar Plastic Kaolin Co. and United Clay Mines Corp. remained the only producers in the State.

Miscellaneous clay output increased 6 percent in tonnage and value, compared with a 4-percent decrease in 1962. Work began about mid-year on construction of a new brick plant of Florida Brick & Clay Co., located in the Plant City Industrial Park, Plant City. The plant, when completed, would begin operations on a small scale.

Gem Stones.—A small quantity of material classified as gem stones was collected by two individuals in Hillsborough and Monroe Counties.

Gypsum.—Calcined gypsum was produced by two companies using Nova Scotia ore, and a third company began constructing a new plant in the Jacksonville area. United States Gypsum Co., near Jacksonville, and National Gypsum Co., at its new plant near Tampa, produced gypsum for building products, including gypsum board and plaster. Kaiser Gypsum Co., a wholly owned subsidiary of Permanente Cement Co., late in the year began constructing a new plant on Dames Point, near Jacksonville. The new plant, now estimated to cost $6.5 million, will have an annual capacity of 180 million square feet of gypsum board products and 40,000 tons of plaster. The plant will use ore from a company-owned deposit in Nova Scotia.

Lime.—Primary lime output increased considerably over that of 1962. Three companies in three counties produced quicklime and hydrated lime for use in chemicals, building products, and other uses. Producers, listed in order of output, were Chemical Lime, Inc., Hernando County; Michigan Chemical Corp., Gulf County, and Dixie Lime & Stone Co., Marion County.

Regenerated lime for manufacturing pulp and paper, for purifying water, and for other uses was produced by several companies during the year. This was the 2d year that regenerated lime output has been reported. Output was 402,000 tons valued at $5.5 million, much less than in 1962.

Magnesia.—Florida, for the 2d consecutive year, ranked third in the Nation in magnesium compounds sold or used. Michigan Chemical Corp., Port St. Joe, Gulf County, produced magnesium compounds from sea water. The company produced caustic calcined

and refractory magnesia for use in insulation, rubber, petroleum, rayon, pulp and paper, chemicals, and for other uses.

Perlite.—Expanded perlite was processed from ore brought in from Western States by three companies in three counties; expanded perlite sold or used was 6,862 tons valued at $475,000. Producers listed in order of output were Chemrock Corp., formerly Tennessee Products & Chemical Corp. (Jacksonville plant), Airlite Processing Corp. of Fla. (Vero Beach plant), Indian River County, and Perlite, Inc. (Hialeah plant), Dade County. The material was used for building plaster, concrete aggregate, soil conditioning, filter aids, and other uses.

Phosphate Rock.—For the 70th consecutive year, Florida led the Nation in total marketable production of phosphate rock. The quantity of all types of phosphate rock produced, including land-pebble, hard and soft rock, increased 5 percent and its value 7 percent compared with 1962. Land-pebble production comprised 99 percent of the total used or sold and was primarily responsible for the total gain; increases in tonnage and value corresponded to the percentages for all types of rock. Hard-rock output increased 28 percent and value 30 percent; 74,000 long tons valued at $698,000 were produced, compared with 58,000 and $538,000 in 1962. Soft-rock output increased 1 percent in tonnage but decreased 2 percent in value; 32,476 long tons valued at $265,000 were produced, compared with 32,013 long tons valued at $270,000 in 1962.

Land-pebble marketable production was 14.5 million long tons valued at $100 million, establishing an alltime high record and exceeding $100 million value for the first time. Mine production of crude ore, dry, was 54,117,000 long tons with a P_2O_5 content of 8,019,000 tons, an increase of 10 percent in tonnage and 14 percent in P_2O_5 content compared with 1962, when there were decreases of 9 and 6 percent, respectively. Land-pebble for agricultural uses totaled 10,539,000 long tons or 73 percent; for industrial uses 408,000 tons or 3 percent; and for export 3,429,000 tons or 25 percent. Agricultural uses were divided as follows: 62 percent in the manufacture of ordinary superphosphate, 30 percent in triple superphosphate, and the remaining 8 percent in nitraphosphate, direct application to the soil as well as stock and poultry feed. For industrial uses, 87 percent went into the manufacture of wet-process phosphoric acid, and the remaining 13 percent was consumed in the manufacture of elemental phosphorus, ferrophosphorus, and phosphoric acid. In the interchange of sales and purchases by mining companies, common to the Florida field, a total of 821,000 tons of processed material with a P_2O_5 content of 266,000 tons was both brought and sold.

Land-pebble phosphate was produced from 16 mines in Polk County and 2 mines in Hillsborough County. Producers, listed in order of total output, were International Minerals & Chemical Corp. (Achan and Noralyn mines), American Agricultural Chemical Co. (Palmetto, South Pierce, and Boyette mines), V-C Corp. Clear Springs and Homeland mines), American Cyanamid Co. (Orange Park and Sydney mines), W. R. Grace & Co., Davison (Bonny Lake mine), Swift & Co. (Varn, Watson and Silver City mines), Armour Agricultural Chemical Co. (Armour mine), Smith-Douglass, Inc. (Tenoroc mine), and New Concept Co. (Green Bay mine).

Hard-rock phosphate continued to be mined by only one company, Kibler-Camp Phosphate Enterprise, Marion County (Section 26 mine), formerly producing in Citrus County.

Soft-rock phosphate was produced by five mines in three counties. Producers, listed in order of output, were Kellogg Co. (Kellogg mine), Citrus County; Soil Builders, Inc. (Mincoll mine), Citrus County; Sun Phosphate Co. (Dunnellon mine), Citrus County; The Loncala Phosphate Co. with mines in Marion County (Minehead mine) and Gilchrist County (Mona mine). All of the soft rock was used in stock and poultry feed and for direct application to the soil.

International Minerals & Chemical Corp. continued as the leading producer of land-pebble phosphate. New company developments announced during the year included the startup of a new phosphoric acid plant at Bonnie that would turn out 900 tons per day of P_2O_5, using closed circuit television and other electronic refinements to automate the plant; a notice late in the year that the company's Prairie phosphate plant, employing 270 persons, would be closed in 1964 because of demands from the Florida State Board of Health concerning air pollution by dusts emitted from the mill and the installation of a new wet-type dust scrubber at the Noralyn plant to help control dust emission. The company also announced the formation of an ocean shipping agency, Transoceanic Freighting Services, which will expedite the shipment of phosphate rock to overseas markets.

American Agricultural Chemical Co., the second largest land-pebble producer in the State, was merged with Continental Oil Co. during the year. Estimated cost of the purchase by Continental was $90 million. Other fertilizer interests owned by Continental, all hydracarbon based, are Petroleum Chemicals, Inc., Lake Charles, La., and Mid-South Chemical Co., a marketing company dealing in plant foods and fertilizers.

V-C Corp., third largest producer of land-pebble phosphate, also merged with an oil company late in the year. Socony Mobil Oil Co. and V-C joined in a stock transfer estimated at $80 million. During the year the company started operation of a $250,000 water neutralization plant at Nichols that eliminated stream and water pollution from phosphate processing; the company also completed a $10 million land swap with the Exchange National Bank of Tampa, trading 1,000 acres of Hillsborough County land for 2 tracts of land near Ft. Meade.

American Cyanamid Co., with mining operations in Hillsborough and Polk Counties, installed a new bag-type dust collector at its phosphate grinding plant in Brewster; the company also sold three tracts of phosphate lands in Polk County to V-C Corp. for an amount in excess of $1 million. The properties are located south and southeast of Bartow and south of Lakeland. The company's phosphate reclamation mining methods, techniques, and simultaneous reclamation system were described.[3]

W. R. Grace & Co., Davison Chemical Division, purchased Robertson Chemical Co., Norfolk, Va., about midyear; Robertson operates five mixed-fertilizer plants in Virginia and North Carolina, making

[3] Custred, U. K. New Mining Methods Rehabilitate Florida's Strip Mines. Min. Eng., v. 15, No. 4, April 1963, pp. 50–52, 60.

both pulverized and semigranulated formulations. Robertson will operate as a part of the Davison Chemical Division.

Armour Agricultural Chemical Co. installed air pollution control equipment in its new concentrated superphosphate plant at Ft. Meade at an estimated cost of $800,000. The new plant, completed about midyear 1962, was a part of the company's plans to expand its triple superphosphate output in Florida. During 1963, the company completed construction of its new 17,500-square-foot Atlanta, Ga., research center.

Kermac Nuclear Corp., mining subsidiary of Kerr-McGee Oil Industries, Inc., purchased Baugh Chemical Co. during the year; Baugh owns over 2,000 acres of phosphate reserves south of Mulberry, Polk County. Kerr-McGee also was reportedly discussing a merger with Smith-Douglass Corp., about midyear, but results of the discussions have not been made public.

Tennessee Corp., large producer of triple superphosphate and diammonium phosphate through its U.S. Phosphoric Products Division, was acquired by Cities Service Co., integrated petroleum producer. Tennessee Corp. will reportedly operate as an autonomous subsidiary of Cities Service Oil Co.

TABLE 4.—Phosphate rock sold or used by producers, by uses

Use	1962			1963		
	Long tons	Value		Long tons	Value	
		Total	Average per ton		Total	Average per ton
Ordinary superphosphate	4,962,937	$34,618,450	$6.98	4,878,805	$34,088,000	$6.99
Phosphoric acid (wet process)	1,979,443	13,315,432	6.73	2,685,878	18,814,481	7.00
Triple superphosphate	2,109,851	14,726,692	6.98	2,344,765	17,600,334	7.51
Elemental phosphorus, ferrophosphorus, phosphoric acid	592,176	4,141,563	6.99	471,275	3,165,273	6.72
Direct application to the soil [1]	693,999	4,876,663	7.03	675,881	4,747,783	7.02
Exports	3,388,767	22,924,418	6.76	3,429,421	23,324,818	6.80
Total	13,727,173	94,603,218	6.89	14,486,025	101,740,689	7.02

[1] Includes stock and poultry feed and nitraphosphate (1963).

TABLE 5.—Marketable production of phosphate rock

(Thousand long tons and thousand dollars)

Year	Hard rock		Soft rock		Land pebble		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	87	$718	65	$437	10,258	$64,079	10,410	$65,234
1959	78	666	52	414	11,434	70,128	11,564	71,208
1960	77	670	47	384	12,197	81,476	12,321	82,530
1961	81	746	42	325	13,666	94,519	13,789	95,590
1962	58	538	32	270	13,859	93,787	13,949	94,595
1963	74	698	32	265	14,486	100,087	14,592	101,050

Sand and Gravel.—Sand and gravel output, showing decreases during 1961 and 1962, increased 27 percent in tonnage and 12 percent in value, establishing a record high. Sand output was 97 percent of the total. Sand and gravel was produced by 48 mines in 21 counties compared

with 19 counties in 1962. The material was transported principally by truck, 4.7 million tons, and by rail, 1.9 million tons; 632,000 tons were transported by waterway. All Government-and-contractor sand was transported by truck and included material produced by State and County highway departments. The three leading counties were, in order of output, Polk, Dade, and Lake. Polk, the leading producing county, continued its large output of sand and was responsible for 31 percent of the total production.

Total sand production was 7.2 million tons valued at $5.3 million. Seventy percent of the material was used for structural purposes, and the remainder was used for fill, paving, glass, and other uses.

Total gravel output was 300,000 tons valued at $513,000 and all of the material was used for paving and structural uses.

Eight new sand and gravel operations reported production for the 1st year.

TABLE 6.—Sand and gravel sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Brevard			47,290	$57,693
Broward	(1)	(1)	406,783	274,486
Dade	283,373	$196,605	1,199,711	608,923
Duval	36,739	27,214	36,000	26,666
Escambia	433,047	483,605	404,715	391,896
Hendry			(1)	(1)
Indian River	10,875	8,700		
Jackson	8,775	6,000		
Lafayette	12,600	18,900		
Lake	916,554	677,948	1,180,708	625,987
Leon	107,300	140,561	97,250	123,135
Orange	150,000	99,750	150,000	136,500
Palm Beach	345	304	564	513
Pinellas	5,400	6,000		
Polk	2,157,765	1,691,019	2,223,740	1,802,405
Putnam	684,493	580,370	623,770	524,533
St. Lucie	(1)	(1)	155,793	150,688
Walton	28,400	21,037	(1)	(1)
Washington	(1)	(1)	20,800	16,000
Undistributed [2]	1,088,229	1,220,574	994,501	1,083,414
Total	5,923,895	5,178,587	7,541,625	5,822,839

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[2] Includes Bay, Clay, Gadsden, Glades, Hillsborough, Volusia Counties, and counties indicated by footnote 1.

Staurolite.—E. I. du Pont de Nemours & Co. Inc., Clay County, the only producer of staurolite in the United States for the past 6 years, continued producing the mineral at a reduced rate; output and value decreased 22 percent. Staurolite, used as an alumina and iron hydroxide additive in cement manufacturing, was recovered as a by-product in concentrating titanium minerals, at Du Pont's Highland and Trail Ridge plants.

Stone.—Florida, for the 4th consecutive year, led the Southeastern States in total stone production and was sixth leading State in the Nation.

TABLE 7.—Sand and gravel sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	4,604,726	$3,603,225	$0.78	5,058,713	$3,669,692	$0.73
Fill	390,069	234,350	.60	1,538,116	782,059	.51
Paving	179,414	162,710	.91	363,764	325,392	.89
Glass	(1)	(1)	(1)	108,807	218,219	2.01
Other sands [2]	323,373	517,555	1.60	172,389	314,548	1.82
Total	5,497,582	4,517,840	.82	7,241,789	5,309,910	.73
Gravel:						
Total [3]	426,313	660,747	1.55	299,836	512,929	1.71
Total sand and gravel	5,923,895	5,178,587	.87	7,541,625	5,822,839	.77

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other sands."
[2] Includes filtration, blast, molding, other uses, and uses indicated by footnote 1.
[3] Includes structural and paving gravel.

Crushed limestone was produced in 24 counties at 81 quarries, 4 more than in 1962. Eleven new producers reported production for the 1st year, the largest number in several years. Eighty-five percent of the material was used for concrete and roadstone, and the remaining 15 percent was used for agricultural purposes, poultry grit, railroad ballast, riprap, asphalt filler, cement, lime, fill, and other uses. Leading counties were Dade, Hernando, and Broward. Leading individual quarries were Florida Rock Products Co. (Diamond Hill quarry), Dixie Lime & Stone Co. (Sumterville quarry), and Ponce Products Corp. (Pennsuco quarry). The stone was transported 65 percent by truck, 34 percent by railroad, and the remainder by waterway. Government-and-contractor stone was produced by 4 county highway departments and totaled 144,000 tons valued at $134,000, compared to 288,000 tons valued at $223,000 in 1962. The stone was used by the counties for road maintenance and construction.

Crushed oystershell was dredged by seven companies in six counties on eight State leases. Only one company produced from two leases. Oystershell output increased considerably. Leading producers, listed in order of output, were Benton & Co., Radcliff Materials Co., and Bay Dredging & Construction Co. Two companies produced oystershell for use in concrete and roadstone and poultry grit and the other five companies produced oystershell for use in concrete and roadstone only. Most of the shell was transported by waterway to docks and then moved by truck to inland points; a small tonnage was also moved by railroad.

Vermiculite.—Zonolite Division of W. R. Grace & Co. exfoliated vermiculite, mined out-of-State, at three plants near Jacksonville, Tampa, and Boca Raton. Verlite Co., Tampa, in its second year of operation, exfoliated vermiculite from crude ore mined in South Africa. Total output of the four plants increased.

TABLE 8.—Crushed limestone sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Alachua	1,261,473	$1,083,243	1,345,784	$1,181,678
Broward	3,968,939	4,458,648	4,789,785	5,284,362
Collier	543,197	610,450	701,848	653,253
Dade	6,727,138	6,872,569	7,508,475	7,329,825
Duval	(1)	(1)		
Hendry	(1)	(1)	100,364	65,961
Hernando	4,770,171	6,546,744	5,826,419	8,235,430
Indian River	1,300	1,560		
Jackson			(1)	(1)
Lafayette	386,407	350,315	(1)	(1)
Levy	526,224	668,289	287,519	554,096
Marion	1,064,648	1,158,583	1,333,791	1,506,001
Monroe	275,000	275,500	242,000	485,000
Pasco	(1)	(1)	8,217	8,217
Pinellas			(1)	(1)
Taylor			(1)	(1)
Volusia			10,000	10,000
Undistributed [2]	6,403,010	8,556,252	7,931,667	10,245,554
Total	25,927,507	30,582,153	30,085,869	35,559,377

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes Citrus, Columbia, Flagler, Lee, Manatee, Palm Beach, Sarasota, Sumter, and Suwannee Counties; and counties indicated by footnote 1.

TABLE 9.—Crushed limestone and oystershell sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	23,392,816	$26,704,036	$1.14	27,237,314	$31,761,444	$1.17
Agstone	479,405	1,446,694	3.02	481,926	1,642,849	3.41
Poultry grit	30,769	461,535	15.00	(1)	(1)	(1)
Other uses [2]	3,375,680	3,995,334	1.18	4,180,665	4,768,899	1.14
Total	27,278,670	32,607,599	1.20	31,899,905	38,173,192	1.20

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes railroad ballast, riprap, asphalt filler, cement, lime, fill, other uses, and uses indicated by footnote 1.

METALS

Ferroalloys.—American Agricultural Chemical Co., Pierce, and V-C Corp., Nichols, produced ferrophosphorus as a byproduct of the electric-furnace process for making elemental phosphorus. Production increased 35 percent, sales 25 percent, and value 18 percent.

Rare-Earth Minerals.—Florida ranked second in the Nation in production of rare-earth minerals for the 2d consecutive year. Titanium Alloy Manufacturing Division of National Lead Co., Jacksonville, recovered monazite as a byproduct of concentrating heavy minerals from the Skinner mine. Output and value decreased below that of 1962, the record year.

Titanium Concentrates.—Florida, for the 8th consecutive year, ranked second in the Nation in production of titanium concentrates. Total

concentrates, including ilmenite and rutile, increased 13 percent in tonnage and 8 percent in value.

Ilmenite output increased 12 percent, and value 3 percent. Three companies in three counties produced ilmenite at four mines. Clay County continued to lead the State with production from two mines. E. I. du Pont de Nemours & Co., Inc. (Highland and Trail Ridge mines) was the leading producer in the State, followed by Titanium Alloy Manufacturing Division of National Lead Co. (Skinner mine) and Florida Minerals Co. (Vero mine). Most of the material was shipped out-of-State for use in pigment manufacture and other uses.

Rutile production increased 50 percent in tonnage and value, compared to decreases of 9 percent in 1962. Titanium Alloy Manufacturing Division of National Lead Co. (Skinner mine) and Florida Minerals Co. (Vero mine) were the only producers of rutile in the State.

Zircon.—For the 24th consecutive year, Florida ranked first in the Nation in zircon output. Total sales by three producing companies increased 6 percent in tonnage and value. Producers, listed in order of output, were E. I. du Pont de Nemours & Co., Inc. (Trail Ridge plant), Titanium Alloy Manufacturing Division of National Lead Co. (Skinner plant), and Florida Minerals Co. (Vero plant). The zircon was recovered in the concentration of other heavy minerals. Most of the material was shipped out-of-State for use in refractories and foundries, and as welding flux.

MINERAL FUELS

Natural Gas.—Production and value of natural gas increased slightly compared with 1962. Production came from the Sunniland field, Collier County, operated by Humble Oil Co.

Peat.—Total sales of peat increased 2 percent in tonnage but decreased 7 percent in value below 1962. Total sales was 21,000 tons valued at $129,000; seven producers in five counties mined peat. Counties, listed in order of output, were Orange, Hillsborough, Putnam, Volusia, and Clay. Two types of peat were produced, humus peat and reed-sedge peat, all the material was used for soil conditioning.

Petroleum.—Preliminary crude petroleum production figures indicated an increase of 12 percent in output and 5 percent in value compared with 1962. The production came from the State's only producing field, Sunniland, in Collier County, operated by Humble Oil Co. Cumulative production to January 1, 1964, was in excess of 7 million barrels of oil.

REVIEW BY COUNTIES

Mineral production was recorded in 43 of the 67 counties, 1 county more than in 1962. Polk, Hillsborough, and Dade, in order of value, were again the three leading mineral producing counties, furnishing 67 percent of the total mineral production value. The leading 10 counties, furnishing 89 percent of the total value, all had values of over $3 million. In addition to those counties previously mentioned, the other seven counties, listed in order of value, were Hernando, Clay,

747-416—64——20

Gadsden, Flagler, Broward, Gulf, and Suwannee; Duval and Marion Counties also furnished substantial mineral production value but are not listed in the top 10 counties. Sand and gravel was produced in 23 counties, limestone in 22, crushed oystershell in 6, peat and phosphate rock in 5, miscellaneous clay in 4; cement, ilmenite and zircon in 3; lime (primary), gem stones, and rutile in 2; kaolin, fuller's earth, natural gas, petroleum, staurolite, monazite, and magnesium compounds, in 1 each. Perlite and vermiculite were processed, and regenerated lime was produced in several counties in the State.

Alachua.—Five companies operated five limestone quarries and produced lime rock for use in concrete and roadstone. The City of

TABLE 10.—Value of mineral production in Florida, by counties[1]

County	1962	1963	Minerals produced in 1963 in order of value
Alachua	$1,083,243	$1,181,678	Limestone.
Bay	(2)	(2)	Sand and gravel.
Brevard		57,693	Do.
Broward	(2)	5,558,848	Limestone, sand and gravel.
Citrus	(2)	(2)	Limestone, phosphate rock, miscellaneous clay.
Clay	(2)	(2)	Ilmenite, zircon, staurolite, sand and gravel, miscellaneous clay, peat.
Collier	(2)	(2)	Petroleum, limetsone, natural gas.
Columbia	(2)	(2)	Limestone.
Dade	(2)	(2)	Cement, limestone, sand and gravel.
Duval	(2)	(2)	Rutile, ilmenite, oyster shell, zircon, monazite, sand and gravel.
Escambia	483,605	(2)	Sand and gravel, miscellaneous clay.
Flagler	(2)	(2)	Cement, limestone.
Gadsden	(2)	(2)	Fuller's earth, sand and gravel, miscellaneous clay.
Gilchrist	(2)	(2)	Phosphate rock.
Glades	(2)	(2)	Sand and gravel.
Gulf	(2)	(2)	Magnesium compounds, lime.
Hendry	(2)	(2)	Sand and gravel, limestone.
Hernando	(2)	(2)	Limestone, lime.
Hillsborough	19,885,804	20,895,544	Cement, phosphate rock, oystershell, sand and gravel, peat, gem stones.
Indian River	(2)	(2)	Rutile, zircon, ilmenite.
Jackson	(2)	(2)	Limestone.
Lafayette	369,215	(2)	Do.
Lake	677,948	625,987	Sand and gravel.
Lee	(2)	(2)	Limestone, oystershell.
Leon	140,561	123,135	Sand and gravel.
Levy	668,289	554,096	Do.
Manatee	(2)	(2)	Limestone.
Marion	(2)	(2)	Limestone, phosphate rock, lime.
Monroe	275,500	435,070	Limestone, gem stones.
Orange	(2)	(2)	Sand and gravel, peat.
Palm Beach	(2)	(2)	Limestone, oystershell, sand and gravel.
Pasco	(2)	8,217	Limestone.
Pinellas	(2)	(2)	Oystershell, limestone.
Polk	87,952,616	94,315,891	Phosphate rock, sand and gravel.
Putnam	(2)	(2)	Sand and gravel, kaolin, peat.
St. Lucie	(2)	150,688	Sand and gravel.
Sarasota	(2)	(2)	Limestone.
Sumter	(2)	(2)	Do.
Suwannee	(2)	(2)	Do.
Taylor		(2)	Do.
Volusia	(2)	(2)	Limestone, sand and gravel, peat.
Walton	453,681	(2)	Oystershell, sand and gravel.
Washington	(2)	16,000	Sand and gravel.
Undistributed[3]	[4] 73,708,538	77,647,153	
Total	[4] 185,700,000	201,620,000	

[1] The following counties are not listed because no production was reported: Baker, Bradford, Calhoun, Charlotte, De Soto, Dixie, Franklin, Hamilton, Hardee, Highlands, Holmes, Jefferson, Liberty, Madison, Martin, Nassau, Okaloosa, Okeechobee, Osceola, St. Johns, Santa Rosa, Seminole, Union, and Wakulla.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes value of natural gas liquids and counties indicated by footnote 2.
[4] Revised figure.

Gainesville, for the 1st year, reported production of regenerated lime for use in its water treatment plant. The following companies, listed in order of output, crushed limestone: Houdaille-Duval Co. (Haile quarry), Ocala Lime Rock Corp. (Haile quarry), Limestone Products, Inc. (Haile quarry), Williston Shell Rock Co. (Buda quarry), and Peacock Lime Rock Co. (Peacock quarry).

Bay.—Calloway Sand Co. (Silver Creek mine) and Cato Sand Co. (Mill Bayou mine), both of Panama City, mined building sand and transported it all by truck. Combined tonnage and value of the two operations increased considerably compared with 1962. International Paper Co. (Panama City limekiln) produced regenerated lime for use in its pulp and paper plant.

Brevard.—Valkaria Sand Co. Inc. (Valkaria Mine), a new producer reporting for the 1st year, mined building sand and a small amount of sand used for fill material. The sand was all transported by truck. This was the first mineral production reported from this county since 1955.

Broward.—The county ranked eighth in value, moving from ninth place in 1962 and was third in output of crushed limestone. Twelve crushed limestone quarries were again active during the year. Only a small portion of the stone was transported by railroad, with the largest share being carried by truck. Eighty-five percent of the stone was used in concrete and as roadstone, and the remainder for other miscellaneous uses. Crushed stone producers, listed in order of output, were Maule Industries, Inc. (Prospect quarry), Hollywood Quarries, Inc. (Broward County quarry), Deerfield Rock Co. (Deerfield quarry), R. H. Wright, Inc. (Green quarry), Sample Rock Co. Inc. (Pompano Beach quarry), Meekins, Inc. (Oakland Park No. 5 and Hollywood quarries), R. H. Wright, Inc. (Wright quarries), Hallandale Rock & Sand Co. (Hallandale quarry), Ferncrest Quarries Corp. (Ferncrest quarry), Rozzo Mining, Inc. (No. 2 quarry), and Broward Rock Co. (Fort Lauderdale quarry), a new producer reporting for the 1st year on operations begun late in the year. Sand output increased markedly over that of 1962 due to new producers reporting for the 1st year. Sand producers, listed in order of output were Bennie F. Matthews (Pompano Beach mine), Dania Fill & Silica Sand Corp. (Dania mine), both new producers reporting for the 1st year, Des Rocher-Davie Sand Corp. (Fort Lauderdale mine), and Florida Silica Sand Co. (Pegram mine). All of the sand was transported by truck and was used for building, fill, and lawn uses.

Citrus.—General Portland Cement Co. crushed limestone and mined miscellaneous clay for use in manufacturing cement at its Tampa plant; limestone output increased but clay decreased. Other limestone producers, listed in order of output, were Indian Waters Development Corp., formerly Colitz Mining Co. (Blue Water quarry), Middleton Mining Co. (Dunnellon mine), and Crystal River Quarries, Inc. (Crystal River quarry). Middleton and Crystal River produced limestone for agricultural purposes, and Indian Waters for concrete and roadstone. Most of the limestone was transported by truck. Kibler Camp Phosphate Enterprise (Section 20 mine) did not report any hard-rock phosphate production from its Citrus County mine during the year; however, the company reported all production came

from Marion County. Soft-rock phosphate was produced by three mines; total output and value remained about the same as in 1962. Producers, listed in order of output, were Sun Phosphate Co. (Dunnellon mine), Soil Builders, Inc. (Mincoll mine), and Kellogg Company (Kellogg mine). Phosphate was used for agricultural purposes.

Clay.—Clay County ranked fifth in total value of mineral production, dropping from fourth ranking county in 1962; it also dropped from third to fifth ranking peat producing county. E. I. du Pont de Nemours & Co. Inc. (Trail Ridge and Highland mines) mined ilmenite, zircon, and staurolite; output and value of ilmenite and zircon increased, but staurolite recovery decreased. All-Florida Sand Co. (Keystone Heights mine) produced building sand; output and value increased substantially. Florida Solite (Russell mine), formerly Southern Lightweight Aggregate Corp., mined miscellaneous clay for use in manufacturing lightweight aggregate for use in building products; output and value increased. Tomes Peat Humus Co., Keystone Heights, produced humus peat for use as a soil conditioner; commercial sales increased.

Collier.—Collier County remained the only crude petroleum and natural gas producing county in the State. Humble Oil & Refining Co. operated 12 wells, of which 2 were drilled and completed in 1962. Preliminary figures indicated that crude petroleum output increased 11 percent and natural gas slightly above 1962. Crushed limestone producers, listed in order of output were Industrial Limerock, Division of Fuller Industries, Inc. (Sunniland quarry), Sunniland Limerock Co. (Sunniland quarry), Naples Limerock Co. (Belle Meade quarry), and Leon McCormick (Naples quarry), a new producer reporting for the 1st year. Most of the material was used in concrete and as roadstone; 77 percent of the stone was transported by truck and the remainder by railroad.

Columbia.—Limerock Industries, Inc. (Columbia City quarry), the only mineral producer in the county, crushed limestone for use in concrete and as roadstone. All of the stone was transported by truck.

Dade.—For the 2d consecutive year, Dade County ranked third in total value of mineral production. The county continued to lead the State in crushed limestone output. Masonry and portland cement production, contributing greatly to the mineral production value of the county, decreased in both output and value compared with 1962. Crushed limestone was produced by 15 companies operating 17 quarries; the leading three individual quarries were Ponce Products Corp. (Pennsuco quarry), Seminole Rock Products, Inc. (Medley quarry), and Ideal Crushed Stone Co. One company, Brooks Paving Co. operated two quarries. Transportation of the crushed stone was 66 percent by truck and 34 percent by railroad. Masonry and portland cement were produced by Lehigh Portland Cement Co. (Miami mill) and General Portland Cement Co. (Everglades mill); crushed limestone used in manufacturing cement was produced in the county. Sand, used for paving, fill, lawn and building purposes, was produced by the following companies, listed in order of output, Sample Sand Co. Inc. (Opa Locka mine), reporting for the first year, Sample Rock Co. (Opa Locka mine), Des Rochers Sand Co. Inc. (Cape Florida mine), and T. J. James Construction Co., formerly Golden Brown

Soil Co. (Miami mine). The City of Miami (Hialeah limekiln) produced regenerated lime for water softening and as a purification agent in its municipal water plant. Perlite, Inc. (Hialeah plant), processed perlite mined in Western States for use in concrete, building plaster, and soil conditioning.

Duval.—Titanium Alloy Manufacturing (Skinner mine) produced ilmenite, rutile, monazite, and zircon; rutile output increased, but ilmenite, monazite and zircon decreased. Houdaille-Duval Co., formerly White Shell Corp., near Jacksonville, crushed oystershell; output more than doubled. The shell was used in concrete, roadstone, and poultry grit. Southside Sand Co. (Jacksonville mine) produced fill sand at about the same rate as in 1962; the company reported that the mine would close at year end. Chemrock Corp., formerly Tennessee Products & Chemical Corp., (Jacksonville plant) processed perlite mined in Western States for use as building plaster, concrete aggregate, soil conditioning, and other uses. Zonolite Co. (Jacksonville plant) processed vermiculite mined in South Carolina, Montana, and South Africa at a slightly increased rate above that of 1962 for use by the building industries. Owens-Illinois Glass Co. (Jacksonville limekiln) produced regenerated lime; output and value were about the same as in 1962; the lime was used in pulp and paper manufacture.

Escambia.—Sand and gravel producers, listed in order of output, were Ward Gravel Co. (Century mine), Escambia County Highway Department which mined 115,000 tons of paving and fill sand valued at $89,000, Campbell Sand & Gravel Co. (Flomaton mine), and Clark Sand Co. (Pensacola mine). Fifty-nine percent of the commercial sand and gravel was transported by railroad and the remainder by truck; all of the Government-and-contractor sand produced by Escambia County Highway Department was transported by truck. Miscellaneous clay output was reported by Taylor Brick & Tile Co. (Barth mine), Pensacola, for the 1st year. The company has been producing building brick or other heavy clay products for many years.

Flagler.—The county ranked seventh in value of mineral production, dropping from sixth place in 1962. Lehigh Portland Cement Co. (Bunnell mill), the only mineral producer in the county, manufactured masonry and portland cements; masonry output declined but shipments of portland increased over those of 1962. The company crushed limestone from its Coquina quarry for use in manufacturing cement; output and value decreased.

Gadsden.—For the 6th consecutive year, the county ranked first in the State and Nation in producing fuller's earth; the county ranked sixth in the State in value of mineral production, moving up from seventh place in 1962. Fuller's earth was mined by three companies, listed in order of output; Minerals & Chemicals Philipp Corp., largest producer in the State, produced from three mines (Willacoochee, La Camelia, and Midway mines); Floridin Co. Inc. (Quincy mine) and Magnet Cove Barium Corp. (Havana mine); total output and value of the five mines increased considerably compared with 1962. Florida Gravel Co. (Chattahoochee mine) produced sand and gravel for building and paving uses at about the same rate as in 1962. Appalachee Correctional Institute (Chattahoochee mine) produced an increased amount of miscellaneous clay for use in building brick.

Gilchrist.—Loncala Phosphate Co. (Mona mine), the only recorded mineral producer in the county, continued operation of its soft-rock phosphate mine; output and value decreased. The material was processed for use in stock and poultry feed and for direct application to the soil.

Glades.—West Coast Rock Co. (Ortona mine), now in its second year of operation under west coast ownership, produced building sand; output and value increased.

Gulf.—The county, ranking eighth in total value of mineral production in 1962, dropped to ninth place. Michigan Chemical Corp. (Port Saint Joe plant) recovered magnesium compounds from sea water and produced caustic calcined and refractory magnesia for use in insulation, rubber, petroleum, rayon, pulp and paper, and chemicals. Michigan Chemical Corp. produced primary lime at its Port Saint Joe limekiln at a reduced rate for use in its magnesium compounds plant. Port Saint Joe Paper Co. (Port Saint Joe limekiln) produced regenerated lime for use in pulp and paper manufacture; output and value decreased.

Hendry.—H & F Limerock Sales (Harris and Flippo quarry), a new operation reporting for the 1st year, crushed limestone for use in concrete and roadstone. Hendry County Highway Department crushed 3,600 tons of limestone valued at $5,000 for use in its road maintenance program. Ortona Sand Co. (La Belle mine), a new sand producer reporting for the 1st year, mined a substantial tonnage of building sand.

Hernando.—The county moved from fifth ranking in total value of mineral production in 1962 to fourth place in 1963, because of increased output of crushed limestone and primary lime. For the 3d consecutive year the county ranked second in crushed limestone output, exceeded only by Dade County. Most of the stone was used in concrete, roadstone, asphalt filler, and for the manufacture of primary lime. Producers, listed in order of output were Florida Rock Products Corp. (Diamond Hill quarry), Camp Concrete Rock Co. (Gay quarry), Wm. P. McDonald Corp. of Florida (Conrock quarry), Lansing Rock Co. (Brooksville quarry), and Ewell Engineering & Contracting Co. (Alderman quarry), reporting for the 1st year; Aripeka Limerock Co. Inc. (Aripeka quarry), Brooksville Rock Co. Inc. (Broco quarry), and Hernando Limerock Co. (Brooksville quarry). Chemical Lime, Inc. (Brooksville limekiln), completing its third year of operation, used crushed limestone supplied by Camp Concrete Rock Co.'s Gay quarry and increased output and value of lime markedly compared with 1962, also a good year.

Hillsborough.—For the 2d consecutive year the county ranked second in total value of mineral production. The county ranked second in the State in land-pebble phosphate and peat output and third in crushed oystershell production. General Portland Cement Co. (Tampa mill) produced masonry and portland cement; masonry output decreased slightly but portland increased. American Cyanamid Co. (Sydney mine) and American Agricultural Chemical Co. (Boyette mine) mined land-pebble phosphate; combined output and value remained about the same as in 1962. Bay Dredging & Construction Co. dredged oystershell from State Lease No. 1703; output and value

increased. Edgar Plastic Kaolin Co. (Plant City mine) produced building and industrial sand; output increased slightly. F. E. Stearns' Peat Co., Valrico, and A. J. Stearns, Seffner, produced humus peat for soil conditioning and improvement. Gem stones were collected by Albert Plaag. Zonolite Division of W. R. Grace & Co. (Tampa plant) and Verlite Co., in the Tampa Area, exfoliated vermiculite for use in building products, soil conditioning and other purposes; combined output and value increased over the previous year.

Indian River.—Florida Minerals Co. (Vero mine) produced ilmenite, rutile, and zircon from beach sands. Airlite Processing Corp. of Florida (Vero Beach plant) expanded crude perlite mined in Western States; output and value decreased.

Jackson.—Green Valley Lime Co. (Marianna quarry), reporting for the 2d year, crushed limestone for agricultural purposes.

Lafayette.—Williston Shell Rock Co. (Chauncey quarry), crushed limestone for use in concrete and roadstone; output and value decreased compared with 1962. Williston's Dell quarry, reporting the previous year, did not produce during 1963. Lafayette County Highway Department crushed 31,000 tons of limestone valued at $31,000 for use in its highway construction and maintenance program.

Lake.—The county ranged third in sand and gravel output and value. Four companies mined sand and one of the sand companies produced a small amount of gravel; producers, listed in order of output, were Eustis Sand Co. (Eustis mine), E. R. Jahna Industries, Inc. (Clermont mine), Silver Lake Estates (Leesburg mine), and Coddings White Sand Co. (Eustis mine), a new producer reporting for the 1st year. Most of the sand was used for building, paving, and blast purposes, and the gravel was used for building purposes. All of the material was transported by truck.

Lee.—West Coast Rock Co. (Fort Myers quarry), crushed limestone for use in concrete and roadstone; output and value increased. All of the stone was transported by truck. Oystershell was dredged by two companies on three offshore State leases; Edison Shell Co. dredged oystershell on two State leases and Fort Myers Shell Co. from Lease No. 1344; combined output of the companies decreased slightly. Most of the oystershell was used in roadstone and concrete and was transported from docksite by truck.

Leon.—Three companies, including a new producer, mined building and paving sand. Asa Maige Sand Co., Tallahassee, changed ownership during the year and continued to lead the county in output of building sand. Other producers were Middle Florida Sand Co. Inc. (Tallahassee mine) and the City of Tallahassee (Tallahassee mine), reporting paving sand output of 9,000 tons valued at $18,000 for the 1st year.

Levy.—Two companies crushed limestone for concrete and roadstone, W & M Construction Co. (Raleigh quarry) and Connell & Shultz (Williston quarry); agricultural limestone producers were Dixie Lime & Stone Co. (Lebanon No. 4 quarry) and Ralph Swiney (Miller quarry).

Manatee.—Florida-Southern Dolomite, Ltd. (Palmetto quarry) crushed limestone for agricultural uses; output and value increased. Chris Wheeler Rock Co. (Manatee quarry) crushed a small tonnage

of limestone for riprap and other uses. All of the stone was transported by truck.

Marion.—Kibler-Camp Phosphate Enterprises (Section 26 mine), formerly operating in Citrus County, mined hard-rock phosphate for the 2d year; output was 74,000 long tons valued at $698,000. Most of the phosphate was used for industrial and agricultural applications. Loncala Phosphate Co. (Minehead mine and plant) mined and processed soft-rock phosphate; output and value increased considerably. Dixie Lime & Stone Co. (Ocala No. 1 limekiln) produced primary lime for building and chemical purposes; output and value increased. Four companies and the county highway department crushed limestone for roadstone, concrete, and agricultural purposes. Producers, listed in order of output, were Ocala Lime Rock Corp. (No. 7 Kendrick quarry), Southern Materials Corp. (Lowell quarry), Dixie Lime & Stone Co. (Kendrick No. 3 quarry), Cummer Lime & Mfg. Co. (Kendrick quarry), and Marion County Highway Department. Combined commercial output was 1.2 million tons valued at $1.4 million, a slight increase over 1962. Fifty-eight percent of the stone was transported by truck, 35 percent by railroad, and the remainder by waterway.

Monroe.—Charley Toppino & Sons, Inc. (Stock Island quarry) crushed limestone for concrete and roadstone; total output was 242,000 tons valued at $485,000, a decrease in tonnage but a considerable increase in value compared with 1962. Don Knowles, Sr., collected a small amount of coral, classified as gem stones.

Orange.—For the 3d consecutive year, the county led in peat production. Daetwyler Peat mine, Orlando, produced reed-sedge peat, and Raymond Johnson, Plymouth, mined humus peat near Zellwood and sold it in bulk for soil improvement purposes. Orange County Highway Department mined 150,000 tons of sand valued at $136,000 for use in paving; output remained the same, but value increased.

Palm Beach.—P. C. Smith Co. Inc. (Palm Beach mine), produced oystershell and reported production for the first time this year; the material was used for road base stabilization. Crushed limestone was produced by Belle Glade Rock Co. (Belle Glade quarry), Palm Beach Mining Co. (West Palm Beach quarry), reporting for the 1st year, and Palm Beach County Highway Department (Palm Beach County mine), which also produced a small tonnage of paving sand. The shell and stone was all transported by truck. Zonolite (Boca Raton plant) exfoliated vermiculite for insulation and other purposes; output and value increased.

Pasco.—Port Richey Mining Corp. (Hudson quarry) continued to crush limestone but at a very reduced rate compared with 1962. The stone was transported by truck and used in concrete and roadstone.

Pinellas.—Benton & Co. (Lease No. 1788) dredged oystershell for use in road construction and concrete; output and value increased considerably compared with 1962. Struthers and Hollash (Pinellas Park quarry) crushed limestone for use in concrete and roadstone and reported production for the 1st year.

Polk.—Polk County continued to rank as the leading county in total value of mineral production; it led the State in land-pebble phosphate and sand and gravel production. The county furnished 47 percent of the total mineral production value of the State. Land-pebble phos-

phate producers, listed in order of tonnage, were International Minerals & Chemical Co. (Achan and Noralyn mines), V-C Corp. (Clear Springs and Homeland mines), American Agricultural Chemical Co. (Palmetto and South Pierce Mines), Swift & Co. (Varn, Watson and Silver City mines), American Cyanamid Co. (Orange Park mine), Armour Agricultural Chemical Co. (Armour mine), Smith-Douglass Co. Inc. (Tenoroc mine); and New Concept Co. (Green Bay mine).

Total sand output, as in 1962, came from 9 mines; 2.0 million tons of sand, valued at $1.5 million, were mined, compared with 2.2 million tons valued at $1.7 million in 1962. One company produced industrial sand, and the remainder produced building, paving, and fill sand. Sixty-seven percent of the sand was transported by railroad, 22 percent by truck, and the remainder by waterway. Producers, listed in order of output, were Standard Sand & Silica Co. (Standard mine), Mammoth Sand Co. (Lake Wales mine), Oak Ridge Sand Co. Inc. (Achan mine), Lake Wales Sand Co. Inc. (Lake Wales mine), Polk City Sand Co. (Polk City mine), Lake Wales Concrete Sand Co. (Lake Wales mine), Lake Wales Independent Sand Co. Inc. (Independent mine), Davenport Sand Co. Inc. (Mammoth mine), and Waverly Road Sand Co. (Winter Haven mine).

Putnam.—The county moved from third ranking sand and gravel producing county to fourth; the county was the only kaolin-producing county in the State. Six mines produced sand compared with eight in 1962. Producers, listed in order of output, were Diamond Interlachen Sand Co., formerly Keuka Sand Co. (Keuka mine), Southern Materials Co. of Florida (Putnam Hall mine), Diamond Interlachen Sand Co. (Interlachen mine), Edgar Plastic Kaolin Co. (Edgar mine), United Clay Mines Corp. (Crossley mine), and Keystone Sand Co. Inc. (Grandin mine). Most of the sand was used for building and industrial purposes. Seventy-seven percent of the sand was transported by truck, and the remainder by railroad. Edgar Plastic Kaolin Co. (Edgar mine) and United Clay Mines Corp. (No. 4 mine) produced kaolin for pottery, stoneware, floor and wall tile, clay crucibles, and other uses; combined output and value increased. Traxler's Peat Co., Florahoma, mined humus peat for use as a soil conditioner. Hudson Pulp & Paper Co. (Palatka limekiln) reported regenerated lime production; output and value increased.

St. Lucie.—Ft. Pierce Sand & Materials, Inc. (White City and Ft. Pierce mines) produced building and fill sand; output increased slightly above that of 1962. Dixie Sand Co. (Edward A. Ulrich mine) produced building sand and reported for the 1st year. All of the sand was transported by truck.

Sarasota.—West Coast Dolomite, Inc. (Venice quarry) crushed limestone for agricultural purposes; the company, formerly producing material for concrete and roadstone, constructed a new plant for processing agricultural limestone in 1962.

Sumter.—Dixie Lime & Stone Co. operated three quarries in the county during the year and was the only mineral producer reporting. The quarries listed in order of output were Sumterville, Mabel, and Coleman; the latter two quarries reported for the 1st year. All of the material was used for concrete and roadstone; 74 percent was transported by truck, and the remainder by railroad.

Suwannee.—The county ranked tenth in total value of mineral production and had the second largest crushed stone operation in the State, exceeded only by the same company's operation in Hernando County. Florida Rock Products Corp. (Suwannee quarry) crushed limestone for concrete asphalt filler and roadstone; output and value continued to increase. Dixie Lime & Stone Co. (Mulkey quarry), reporting for the 2d year, crushed limestone at an increasing rate for use in concrete and roadstone. Suwannee Dolomite & Lime Co. (Live Oak quarry) crushed limestone and processed it for agricultural purposes; output and value increased compared with 1962. Ocala Lime Rock Corp. (Lanier quarry) crushed limestone for concrete and roadstone and reported production for the first year.

Taylor.—Williston Shell Rock Co. (Perry quarry) crushed limestone for concrete and roadstone and reported for the first time this year. Buckeye Cellulose Corp. (Foley limekiln) produced regenerated lime for pulp and paper manufacture at an increased rate over that of 1962.

Volusia.—White Sand & Materials Co. (New Smyrna Beach mine) and Houser Concrete Co. (Deland mine) produced small tonnages of building sand. J & B Construction Co. crushed limestone for concrete as well as roadstone and reported for the 1st year. Tomoka Peat & Rock Co. Inc., Daytona Beach, produced humus peat and reported production and sales for the 1st year; the material was used for soil improvement purposes.

Walton.—Walton County was the second leading county in oystershell output, exceeded only by Pinellas County by a small margin; during 1961 and 1962 the county led the State. Radcliff Materials, Inc., a division of Southern Materials Corp., Mobile, Ala., dredged oystershell from State Lease No. 1718; output and value increased, compared with 1962. Adams Sand Co. Inc. (Mossy Head mine), reporting for the 2d year, mined building sand.

Washington.—Miller and Jerkins (Wausau mine), the only mineral producer in the county, produced building, paving, and fill sand; output and value increased, compared with 1962.

The Mineral Industry of Georgia

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Georgia for collecting information on all minerals, except fuels.

By James L. Vallely [1] and Garland Peyton [2]

MINERAL PRODUCTION in Georgia continued to expand with a record value of $119.5 million, an increase of 11 percent over that in 1962. Cement, kaolin, dimension marble, and crushed stone were primarily responsible for the increase. Barite, fuller's earth, miscellaneous clay, iron ore, scrap mica, and sand and gravel also showed substantial gains. Bauxite, feldspar, talc, coal, and peat were lower in both tonnage and value. For the first time in many years, no manganiferous ores or sheet mica were produced in Georgia.

Georgia ranked first among the States in output of kaolin, second in scrap mica and fuller's earth, third in bauxite, and fourth in barite and feldspar. Georgia also was first in output of granite and marble, both crushed and dimension, and crushed slate.

TABLE 1.—Mineral production in Georgia [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—thousand short tons	109	$1,987	117	$2,013
Clays—do	3,801	47,462	4,208	54,024
Coal (bituminous)—do	8	28	5	16
Feldspar—thousand long tons	36	795	[2]	[2]
Gem stones	[3]	[4]	[3]	1
Iron ore (usable)—thousand long tons, gross weight	215	1,118	260	1,304
Mica, sheet—pounds	60	1		
Sand and gravel—thousand short tons	3,429	3,365	3,817	3,922
Stone—do	19,555	42,037	19,582	46,044
Talc and soapstone—short tons	45,940	96	42,000	93
Value of items that cannot be disclosed: Bauxite, cement, kyanite (1963), manganiferous ore (1962), mica (scrap), peat, and values indicated by footnote 2		10,816		12,059
Total		107,705		119,476

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Weight not recorded.
[4] Less than $500.

[1] Mining engineer, Bureau of Mines, Knoxville, Tenn.
[2] Director, Geological Survey of Georgia, Atlanta, Ga.

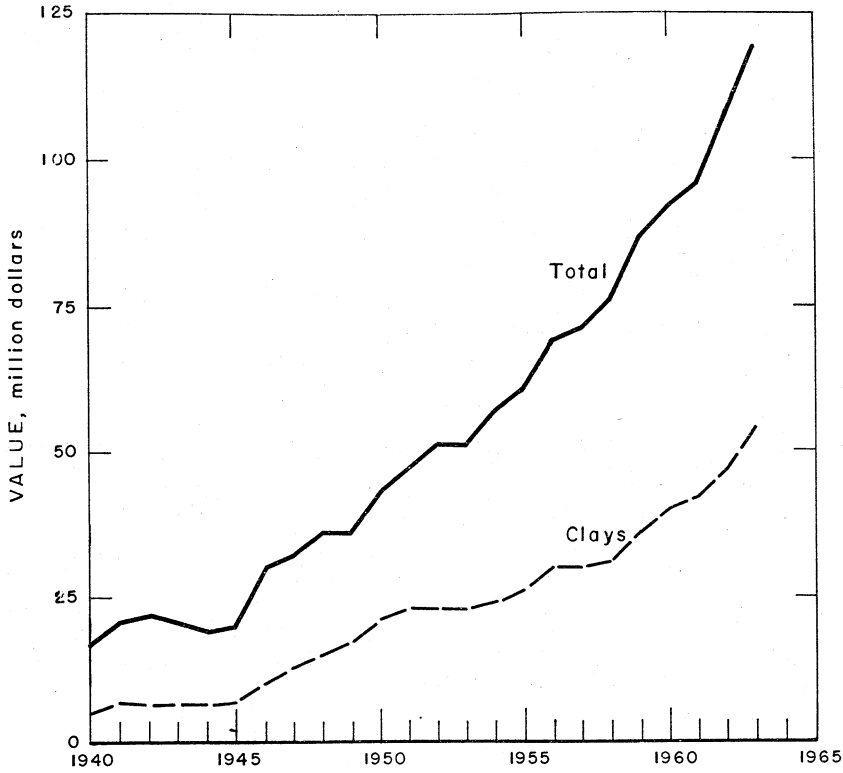


FIGURE 1.—Value of clays, and total value of mineral production in Georgia, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$61,358	1958	$76,575
1953	59,532	1959	86,007
1954	62,909	1960	90,817
1955	67,721	1961	93,686
1956	70,275	1962	101,528
1957	71,648	1963	115,301

Trends and Developments.—The most important development in Georgia's mineral industry in 1963 was the initial production by Southern Cement Co., Division of Martin Marietta Co. at a new cement plant in Atlanta. The $18 million, 1.4-million-barrel-annual capacity mill went on stream in June. Continuing the trend toward widespread cement distribution plants, four more depots were completed during the year; Lehigh, Marquette, and Penn-Dixie built plants at Atlanta, and Atlantic Cement Co. completed a 16-silo, 160,000-barrel storage plant with bagging facilities at Savannah.

Aluminum Silicates, Inc. reported production of kyanite from a new mine and mill near Lincolnton. Consolidated Quarries, Division of Georgia Marble Co., became a producer of feldspar-quartz concentrate with a new flotation unit to recover the mixture from fines of the quarry operation. Flintkote Co. announced plans to build a $8.5 million gypsum processing plant at Savannah; American Cyanamid Co. announced that modifications to cost from $1 to $2 million will be made at its titanium dioxide pigment plant at Savannah. Early in the year, Atlantic Steel Co. placed in operation a new 35-inch blooming mill and soaking pit installation. The mill, soaking pit, buildings, and related facilities were installed at a cost of $5 million.

Water.—In 1963 the Bureau of Mines conducted a special canvass to obtain data for 1962 on the usage of water in the mineral industries. Table 3 shows the total amounts and the new and recirculated water used by the different segments of the mineral industry. Quarries and mills recirculated 30 percent of its total water use and metal mines and mills recirculated 19 percent; however, nonmetal mines and mills and sand and gravel plants, the two largest water consumers, recirculated only 10 percent and less than 1 percent of their total water usage, respectively.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Industry	New water	Recirculated water	Total water use
Quarries and mills	2,567	1,122	3,689
Metal mines and mills	211	48	259
Nonmetal mines and mills	6,480	712	7,192
Sand and gravel mines	5,502	1	5,503
Total	14,760	1,883	16,643

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—Primary barite increased 7 percent in tonnage and 1 percent in value. It was produced by four companies in Bartow County. The leading producers were New Riverside Ochre Co. and Paga Mining Co. Primary barite was shipped for barite chemicals and well drilling, and crushed and ground barite were shipped for well drilling, paint, and rubber fillers.

Cement.—Cement ranked third in value in the State's mineral production. Output of portland cement increased substantially over that of 1962 due to the opening at midyear of a new 1.4-million-barrel-capacity plant by Southern Cement Co. at Atlanta. Masonry cement production declined 7 percent in quantity but increased 31 percent in value. Other cement producers were Marquette Cement Manufacturing Co. (portland and masonry cements) at Rockmart and Penn-Dixie Cement Corp. (portland cement) at Clinchfield. Out-of-State shipments were principally to Florida, with smaller tonnages to Alabama, North Carolina, South Carolina, and Tennessee.

Clays.—In production value, clays were the most important of the State's minerals, comprising 45 percent of the total. Kaolin production increased 9 percent in tonnage and 13 percent in value, fuller's earth 27 percent in tonnage and 37 percent in value, and miscellaneous clay 12 percent in tonnage and 21 percent in value.

Georgia continued to lead the Nation in kaolin production and ranked second in fuller's earth. Eighteen companies mined kaolin in 8 counties (Baldwin, Floyd, Macon, Richmond, Sumter, Twiggs, Washington, and Wilkinson); 6 companies produced fuller's earth in Decatur, Jefferson, Thomas, and Twiggs Counties; and 14 companies mined miscellaneous clay in 10 counties. Leading producers of kaolin were American Industrial Clay Co., Freeport Kaolin Co., Georgia Kaolin Co., J. M. Huber Corp., Minerals & Chemicals Philipp Corp., and Thiele Kaolin Co. Freeport Sulphur Co. purchased the assets of Southern Clays, Inc., and in June, Freeport Kaolin Co. began operation as a division of Freeport Sulphur. Producers of fuller's earth were Cairo Production Co., Diversey Corp., Georgia-Tennessee Mining & Chemical Co., Milwhite Co. Inc., Minerals & Chemicals Philipp Corp., and Waverly Petroleum Products Co.; principal producers of miscellaneous clay were Burns Brick Co., Chattahoochee Brick Co., Cherokee Brick Co., Merry Bros. Brick & Tile Co., and Oconee Clay Products Co.

TABLE 4.—Kaolin sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Richmond	77,806	$608,060	(1)	(1)
Twiggs	(1)	(1)	1,232,389	$26,682,124
Washington	769,036	16,142,840	832,774	17,807,996
Other counties [2]	1,431,442	27,904,369	424,834	5,803,763
Total	2,278,284	44,655,269	2,489,997	50,293,883

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other counties."
[2] Includes Baldwin, Floyd, Macon, Sumter, and Wilkinson Counties, and counties indicated by footnote 1.

TABLE 5.—Kaolin sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Pottery and stoneware:						
Whiteware	81,982	$1,626,884	$19.84	64,474	$1,469,960	$22.80
Art pottery, etc.	3,245	57,419	17.69	(1)	(1)	(1)
Refractories:						
Fire brick and block	163,709	1,259,646	7.69	200,316	1,532,519	7.65
Fire-clay mortar	(1)	(1)	(1)			
Fillers:						
Paper filling	577,764	11,417,028	19.76	590,601	12,093,169	20.48
Paper coating	967,491	21,705,468	22.43	1,046,091	23,920,578	22.87
Rubber	100,929	1,339,884	13.28	113,121	1,687,715	14.92
Paint	46,850	987,320	21.07	60,542	1,362,574	22.51
Fertilizers	7,579	136,623	18.03	(1)	(1)	(1)
Insecticides and fungicides	7,898	98,045	12.41	7,181	94,298	13.13
Chemicals	20,930	328,824	15.71	(1)	(1)	(1)
Exports	89,128	2,037,156	22.86	126,266	3,073,383	24.34
Other uses [2]	210,779	3,660,972	17.37	281,405	5,059,687	17.98
Total	2,278,284	44,655,269	19.60	2,489,997	50,293,883	20.20

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes stoneware (including chemical stoneware), enameling, floor and wall tile, bauxite (high-alumina brick), glass refractories, foundries and steelworks, saggers, pins, stilts, wads, other refractories, linoleum and oilcoth, organic plastics, other fillers, portland and other hydraulic cements, catalysts, other uses, and uses indicated by footnote 1.

TABLE 6.—Miscellaneous clay sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Crawford	(1)	(1)	400	$180
Fulton	(1)	(1)	296,076	154,750
Gordon	27,465	$12,100	28,456	12,800
Richmond	569,825	250,700	604,923	277,300
Whitfield	4,400	1,950		
Other counties [2]	813,850	374,779	651,482	326,199
Total	1,415,540	639,529	1,581,337	771,229

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other counties."
[2] Includes Bibb, Columbia, Floyd, Houston, Polk, and Walker Counties, and counties indicated by footnote 1.

Feldspar.—The Feldspar Corp. mined feldspathic rock in Jasper County and produced feldspar flotation concentrate at its mill near Monticello for use in glass and pottery. Consolidated Quarries, a division of Georgia Marble Co., began producing feldspar-quartz flotation concentrate, a byproduct obtained from fines of the granite-quarrying operation. The 60 to 40 percent feldspar-quartz mixture was used in manufacturing glass.

Gem Stones.—Numerous individuals collected mineral specimens and gem materials valued at more than $1,000 throughout the State. Principal minerals reported were agate, garnet, quartz feldspar, and sulfates.

Gypsum.—Bestwall Gypsum Co. (Brunswick) and National Gypsum Co. (Savannah) calcined imported gypsum and manufactured wallboard and other gypsum products. The Flintkote Co. announced plans to build a $8.5 million gypsum processing plant on the Savannah River at Savannah.

Kyanite.—Aluminum Silicates, Inc. reported initial production of kyanite from a new mine and mill at Graves Mountain, near Lincolnton, Lincoln County.

Lime.—Production of regenerated lime was 315,000 tons valued at $5.9 million, an increase of 20 percent in both tonnage and value. This lime was produced and reused principally by pulp and paper companies by burning calcium carbonate sludge in rotary kilns. Data on regenerated lime are not included in table 1 of this chapter. No primary lime has been produced in Georgia since 1954.

Mica.—No sheet mica was produced in 1963. Scrap mica was mined and ground by two companies in Cherokee and Hart Counties. Ground mica production increased 6 percent and 7 percent, respectively, in tonnage and value. Principal uses were for plastics, paint, rubber, and wallboard joint cement.

Sand and Gravel.—Output of sand and gravel, ranking fourth in the State's mineral production, increased 11 and 17 percent in tonnage and value, respectively. Structural and paving sand together increased 8 percent in tonnage and 16 percent in value, and comprised 75 percent of the total value. Blast, glass, molding, and railroad sand output decreased more than 10 percent while fill and filter sands were higher. Gravel production more than doubled.

TABLE 7.—Sand and gravel sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Brooks	101,393	$108,519	66,586	$66,621
Chatham	(1)	(1)	15,103	18,979
Chattooga	1,675	3,936	(1)	(1)
Cook	91,000	97,591	73,188	103,433
De Kalb	(1)	(1)	24,428	33,840
Dougherty	167,048	151,029	137,692	127,863
Elbert	86	740		
Evans	10,000	15,000	9,600	8,000
Franklin			(1)	(1)
Fulton	(1)	(1)	69,938	81,333
Houston			(1)	(1)
Lumpkin			(1)	(1)
Montgomery	21,600	16,000	37,000	37,000
Richmond	(1)	(1)	30,000	25,500
Sumter	(1)	(1)		
Taylor	(1)	(1)	446,862	305,117
Telfair	10,500	10,500	(1)	(1)
Tift	22,000	19,500		
Towns	(1)	(1)		
Walker	18,317	24,966		
White	9,800	10,568	(1)	(1)
Undistributed [2]	2,975,629	2,906,179	2,906,288	3,114,284
Total	3,429,048	3,364,528	3,816,685	3,921,970

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[2] Includes Bibb, Camden, Crawford, Effingham, Glynn, Greene, Long, Muscogee, Talbot, Thomas, and Ware Counties, and counties indicated by footnote 1.

TABLE 8.—Sand and gravel sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	2,172,816	$1,590,185	$0.73	2,366,214	$1,866,790	$0.79
Paving	470,560	340,612	.72	497,245	377,751	.76
Fill	47,992	35,588	.74	53,856	38,077	.71
Railroad ballast	76,168	75,941	1.00	(1)	(1)	(1)
Other sands	(2)	(2)	(2)	[3] 346,768	[3] 795,510	[3] 2.29
Total sand	(2)	(2)	(2)	3,264,083	3,078,128	.94
Gravel	(2)	(2)	(2)	[4] 552,602	[4] 843,842	[4] 1.53
Total sand and gravel	[5] 3,429,048	[5] 3,364,528	[5] .98	3,816,685	3,921,970	1.03

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other sands."
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Total sand and gravel."
[3] Includes glass, molding, blast, filtration, other sands, and uses indicated by footnote 1.
[4] Includes structural, paving, fill, and other gravel.
[5] Includes glass, blast, and other sands, and structural, paving, and other gravel.

Twenty-five companies produced sand only from 31 pits in 23 counties, 2 companies produced gravel from 2 pits in Franklin and Chattooga Counties, and 5 companies produced both sand and gravel from 5 pits in 4 counties. Crawford, Muscogee, Taylor, Talbot, and Thomas were the principal producing counties. Atlanta Sand & Supply Co. (Crawford County), Brown Bros. Sand Co. and Taylor Sand Co. (Talbot County), J. J. Brown Sand & Gravel Co. and Calhoun Sand & Gravel Co. (Muscogee County), Dawes Silica Mining Co., Inc. (Dougherty, Effingham, Long, and Thomas Counties), and Howard Sand Co. (Taylor County) were the principal producers; of the 39 sand and gravel plants, 15 produced less than 50,000 tons in 1963, 11 between 25,000 and 100,000 tons, 11 from 100,000 to 300,000 tons, 1 between 300,000 and 400,000 tons, and 1 between 600,000 and 700,000 tons.

Stone.—Stone ranked second in value in the State's mineral production. Total output of all stone was about the same in quantity as in 1962 but was 10 percent higher in value. All crushed stone except sandstone (quartz and quartzite) and granite increased in tonnage and value; sandstone decreased 15 and 11 percent, respectively, in tonnage and value, and granite was 3 percent lower in tonnage but 1 percent higher in value. Crushed limestone, marble, and slate were 20, 10, and 11 percent higher in tonnage, and 11, 3, and 12 percent higher in value, respectively. Dimension granite rose 6 percent in tonnage but declined 15 percent in value; dimension marble increased 50 percent in tonnage and over 70 percent in value. Small tonnages of dimension limestone and sandstone were also produced.

Stone was produced from 81 quarries in 33 counties by 56 companies and Government-and-contractor operations. Dimension granite was produced in 5 counties and 31 quarries by 26 companies, crushed granite in 17 counties from 22 quarries by 10 companies, and crushed limestone in 8 counties by 11 companies and 1 Government-and-contractor operation. Crushed and dimension marble was produced in

Pickens County and crushed marble only in Chattooga and Gilmer Counties. Crushed slate was mined in Bartow and Polk Counties, quartzite in Richmond, crushed sandstone in Greene County, and dimension sandstone in Bartow and Pickens Counties.

Leading producers of crushed granite were Dixie Lime & Stone Co., Stockbridge Stone Division of Vulcan Materials Co., and Weston & Brooker Co.; and of dimension granite, Coggins Granite Industries, Inc., Comolli Granite Co., and Davidson Granite Co. Inc. Georgia Marble Co. produced crushed and dimension marble, and Marble Products Co. produced crushed marble only. Excluding the cement companies, the principal producers of crushed limestone were Dalton Rock Products Co., Ready-Mix Concrete Co. Inc., and Rossville Crushed Stone Co., Superior Stone Co., division of Martin Marietta Corp., was the only producer of quartzite. Funkhouser Mills Division of the Ruberoid Co. mined and crushed slate for roofing granules, and Georgia Lightweight Aggregates Co. mined and crushed slate for lightweight aggregates.

Talc and Soapstone.—Production of crude talc decreased 9 percent in tonnage and 3 percent in value. Georgia Talc Co., Murray County, the only producer, mined and processed crude talc for asphalt filler, insecticides, roofing, rubber, and other uses.

Vermiculite.—Zonolite Division of W. R. Grace & Co. at Atlanta exfoliated crude vermiculite shipped into the State.

TABLE 9.—Crushed granite sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roadstone	12,885,655	$17,696,447	$1.37	12,481,834	$17,409,782	$1.39
Railroad ballast	823,279	934,034	1.13	(1)	(1)	(1)
Riprap	374,263	483,573	1.29	372,661	541,448	1.45
Other [2]	727,602	1,202,519	1.65	1,559,243	2,629,537	1.69
Total	14,810,799	20,316,573	1.37	14,413,738	20,580,767	1.43

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes stone sand, poultry grit, filter sand, other uses, and uses indicated by footnote 1.

TABLE 10.—Dimension granite sold or used by producers, by counties

County	1962			1963		
	Cubic feet	Short tons (equivalent)	Value	Cubic feet	Short tons (equivalent)	Value
De Kalb	986,837	81,749	$1,285,718	1,099,076	91,223	$1,268,031
Elbert	561,540	46,604	1,729,541	610,571	50,676	1,398,879
Hancock	25,913	2,151	38,869	50,752	4,212	49,557
Madison	184,618	15,323	461,545	179,718	14,917	549,938
Oglethorpe	(1)	(1)	(1)	284,091	23,584	631,433
Rockdale	(1)	(1)	(1)			
Total	2,099,877	174,349	4,568,223	2,224,208	184,612	3,897,838

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Total."

TABLE 11.—Dimension granite sold or used by producers, by uses

Use	1962			1963		
	Cubic feet	Value		Cubic feet	Value	
		Total	Average per cubic foot		Total	Average per cubic foot
Rough monumental	834,088	$1,704,185	$2.04	977,350	$2,004,273	$2.05
Rubble	(1)	(1)	(1)	647,916	138,376	.21
Curbing and flagging	446,723	839,520	1.88	354,533	542,023	1.53
Dressed monumental	156,749	1,254,127	8.00	(1)	(1)	(1)
Rough construction				45,470	41,634	.92
Other [2]	662,317	770,391	1.16	198,939	1,171,532	5.89
Total	2,099,877	4,568,223	2.18	2,224,208	3,897,838	1.75

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes rough and dressed architectural stone and uses indicated by footnote 1.

TABLE 12.—Crushed limestone sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roadstone	1,290,284	$1,987,556	$1.54	1,756,738	$2,330,217	$1.33
Agstone	(1)	(1)	(1)	210,336	435,399	2.07
Other [2]	1,002,156	1,589,650	1.59	776,875	1,191,153	1.53
Total	2,292,440	3,577,206	1.56	2,743,949	3,956,769	1.44

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes cement, railroad ballast, riprap, and uses indicated by footnote 1.

METALS

Bauxite.—Production of bauxite from Bartow, Floyd, and Sumter Counties was considerably lower than in 1962; shipments, however, were 15 percent higher. American Cyanamid Co., the only producer, shipped to the company's Hall Station drying plant and direct to consumers.

Iron Ore.—Shipments of brown iron ore increased 20 percent in tonnage and 17 percent in value, the average unit value decreasing from $5.20 to $5.02 per ton. More than 80 percent of the ore was mined in the Stewart-Webster-Dooly district south of the fall line and the remainder in the Bartow-Polk County area in the northwestern part of the State. Production in the Bartow-Polk area, including crude iron oxide pigments, increased 16 percent to 46,653 tons; in the Stewart-Webster-Dooly area production rose 22 percent to 213,000 tons.

Crude iron oxide pigments decreased 19 percent and 11 percent, respectively, in tonnage and value; finished pigments also were lower in tonnage and value.

MINERAL FUELS

Coal (Bituminous).—Only one underground mine producing more than 1,000 tons was active. W. T. Blevins Coal Co. of Walker County produced 5,000 tons valued at $16,000.

Peat.—Humus peat was produced by two companies in Lowndes County for agricultural and horticultural purposes.

REVIEW BY COUNTIES

Mineral production was reported from 77 counties, 1 more than in 1962. Twenty counties had production valued above $1 million and constituted 88 percent of the State total. The 12 leading counties, each having production exceeding $2 million, in descending order were Twiggs, Washington, Pickens, Houston, Polk, De Kalb, Wilkinson, Fulton, Bartow, Richmond, Muscogee, and Jones.

Baldwin.—General Refractories Co. mined kaolin at the Wood mine for the manufacture of fire brick and block.

Barrow.—F. C. Boland collected a small quantity of quartz for mineral specimens.

Bartow.—Value of mineral production increased 2 percent. New production of dimension sandstone and bauxite, with increases in barite and brown iron ore production, more than offset lower output in crushed limestone and sandstone. Leading crude barite producers were Paga Mining Co. and New Riverside Ochre Co., the latter company was also the only producer of crude and finished iron oxide pigments in the State. Thompson-Weinman & Co. operated a grinding plant at Cartersville to produce fillers and extenders from barite, kaolin, marble, mica, and other minerals. Marquette Cement Manufacturing Co. quarried limestone for use in its cement plant at Rockmart, and Funkhouser Mills Division of The Ruberoid Co. mined and crushed slate at its Fairmount mine for roofing granules and slate flour. Troy Upshaw reported initial production of dimension sandstone for rough architectural use. American Cyanamid Co. resumed mining of bauxite ore and continued operation of its Halls Station drying plant. Hodge Mining Co. and Joe Mosteller were the only active iron ore operators. A small quantity of mineral specimens was collected.

TABLE 13.—Value of mineral production in Georgia, by counties[1]

County	1962	1963	Minerals produced in 1963 in order of value
Baldwin	(2)	(2)	Kaolin.
Barrow		$25	Gem stones.
Bartow	$3,127,289	3,197,519	Barite, slate, limestone, iron ore, sandstone, iron oxide pigments, bauxite, gem stones.
Bibb	312,900	332,439	Sand and gravel, miscellaneous clay.
Brooks	108,519	66,621	Sand and gravel.
Camden	(2)	(2)	Do.
Chatham	(2)	18,979	Do.
Chattooga	3,936	(2)	Marble, sand and gravel, gem stones.
Cherokee	(2)	(2)	Mica, gem stones.
Clarke	(2)	(2)	Granite.
Clayton	(2)	(2)	Do.
Cobb	(2)	(2)	Granite, gem stones.
Columbia	(2)	(2)	Miscellaneous clay.
Cook	97,591	103,433	Sand and gravel.
Crawford	(2)	(2)	Sand and gravel, miscellaneous clay.
Dade	(2)	(2)	Limestone.
Decatur	(2)	(2)	Fuller's earth.
De Kalb	(2)	(2)	Granite, feldspar, sand and gravel.
Dooly	(2)	140,350	Iron ore.
Dougherty	151,029	127,863	Sand and gravel.
Douglas	(2)	(2)	Granite.

See footnotes at end of table.

TABLE 13.—Value of mineral production in Georgia, by counties[1]—Continued

County	1962	1963	Minerals produced in 1963 in order of value
Effingham	(2)	(2)	Sand and gravel.
Elbert	(2)	$1,598,879	Granite.
Evans	$15,000	8,000	Sand and gravel.
Fannin	(2)	(2)	Limestone, gem stones.
Fayette	(2)	(2)	Granite.
Floyd	1,019,749	(2)	Limestone, miscellaneous clay, bauxite, kaolin, gem stones.
Franklin		(2)	Sand and gravel.
Fulton	(2)	3,473,642	Granite, cement, miscellaneous clay, sand and gravel.
Gilmer	(2)	(2)	Marble.
Glynn	(2)	(2)	Sand and gravel.
Gordon	12,100	12,800	Miscellaneous clay.
Greene	(2)	(2)	Sand and gravel, sandstone.
Gwinnett	(2)	(2)	Granite.
Hall	(2)	(2)	Do.
Hancock	(2)	(2)	Do.
Haralson		15	Gem stones.
Hart	(2)	(2)	Mica.
Henry	(2)	(2)	Granite.
Houston	(2)	(2)	Cement, limestone, sand and gravel, miscellaneous clay.
Jasper	(2)	458,068	Feldspar, gem stones.
Jefferson	(2)	(2)	Fuller's earth.
Jones	(2)	(2)	Granite.
Lamar	(2)	(2)	Granite, gem stones.
Lincoln	15	(2)	Kyanite, gem stones.
Long	(2)	(2)	Sand and gravel.
Lowndes	(2)	(2)	Peat.
Lumpkin	(2)	(2)	Sand and gravel, gem stones.
Macon	(2)	(2)	Kaolin.
Madison	461,545	549,938	Granite.
Meriwether	(2)		
Mitchell	(2)	(2)	Limestone.
Montgomery	16,000	37,000	Sand and gravel.
Murray	95,600	93,300	Talc, soapstone.
Muscogee	(2)	(2)	Granite, sand and gravel, gem stones.
Oconee	(2)		
Oglethrope	745,076	631,433	Granite.
Paulding		10	Gem stones.
Pickens	(2)	(2)	Marble, sandstone.
Polk	(2)	(2)	Cement, slate, miscellaneous clay, iron ore, sandstone.
Rabun	(2)	135,000	Granite.
Richmond	(2)	(2)	Sandstone, kaolin, miscellaneous clay, sand and gravel.
Rockdale	(2)		
Stewart	(2)	564,550	Iron ore.
Sumter	(2)	(2)	Bauxite, kaolin.
Talbot	(2)	(2)	Sand and gravel.
Taylor	(2)	305,117	Do.
Telfair	10,500	(2)	Do.
Thomas	(2)	(2)	Fuller's earth, sand and gravel.
Tift	19,500		
Towns	(2)	200	Gem stones.
Troup		290	Do.
Twiggs	24,208,460	27,139,078	Kaolin, fuller's earth.
Walker	761,747	(2)	Limestone, miscellaneous clay, coal, gem stones.
Ware	(2)	(2)	Sand and gravel.
Warren	(2)	(2)	Granite.
Washington	16,142,840	17,807,996	Kaolin.
Webster	(2)	(2)	Iron ore.
White	10,568	(2)	Sand and gravel.
Whitfield	(2)	(2)	Limestone.
Wilkinson	(2)	(2)	Kaolin.
Undistributed	60,384,801	62,673,455	
Total	107,705,000	119,476,000	

[1] The following counties are not listed because no production was reported: Appling, Atkinson, Bacon, Baker, Banks, Ben Hill, Berrien, Bleckley, Brantley, Bryan, Bulloch, Burke, Butts, Calhoun, Candler, Carroll, Catoosa, Charlton, Chattahoochee, Clay, Clinch, Coffee, Colquitt, Coweta, Crisp, Dawson, Dodge, Early, Echols, Emanuel, Forsyth, Glascock, Grady, Habersham, Harris, Heard, Irwin, Jackson, Jeff Davis, Jenkins, Johnson, Lanier, Laurens, Lee, Liberty, McDuffie, McIntosh, Marion, Miller, Monroe, Morgan, Newton, Peach, Pierce, Pike, Pulaski, Putnam, Quitman, Randolph, Schley, Screven Seminole, Spalding, Stephens, Taliaferro, Tattnall, Terrell, Toombs, Treutlen, Turner, Union, Upson, Walton, Wayne, Wheeler, Wilcox, Wilkes, and Worth.

[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Bibb.—Burns Brick Co. and Cherokee Brick & Tile Co. mined miscellaneous clay for brick and other clay products. Cornell-Young Co. produced sand and gravel at the Macon and Warner Robbins pits, and Sand Suppliers, Inc. mined sand for building and paving.

Brooks.—Bannockburn Sand Co. mined building, paving, and fill sand near Valdosta.

Camden.—Gray Towing Co. produced building sand at Brunswick. St. Marys Kraft Corp. calcined papermill sludge to lime for recirculation in the mill process.

Chatham.—Fitzgerald-Montgomery Sand Corp. mined building and paving sand. Continental Can Co. calcined papermill sludge to lime for reuse in the pulpmill. National Gypsum Co. calcined imported crude gypsum for use in its building products plant at Savannah.

Chattooga.—Marble Products Co. of Georgia opened a new mine for the production of terrazzo chips. Wolf Creek Sand Co. produced molding sand. Several individuals collected a quantity of agate for gem material.

Cherokee.—Ben Jones mined scrap mica for grinding by Thompson-Weinman & Co. Quartzite and verde antique were collected for gem material.

Clarke.—Gainesville Stone Co. quarried granite for riprap, concrete, and roadstone.

Clayton.—Tyrone Rock Division of Dixie Lime & Stone Co. quarried and crushed granite at Clayton for concrete and roadstone.

Cobb.—Stockbridge Stone Division of Vulcan Materials Co. produced crushed granite for concrete and roadstone at the Kennesaw quarry. Several individuals collected garnet for gem material or mineral specimens.

Columbia.—Georgia Vitrified Brick & Clay Co. mined miscellaneous clay at the Campania mine for brick, pipe, and other clay products.

Cook.—Bannockburn Sand Co. produced building sand at the Burneyhill mine.

Crawford.—Atlanta Sand & Supply Co. produced building, paving, blast, and railroad sand at the Rollo mine. Middle Georgia Pottery Co. mined miscellaneous clay for making art pottery.

Dade.—Dave L. Brown Co. operated the Morganville quarry and produced crushed limestone for concrete and roadstone.

Decatur.—The Milwhite Co. and Minerals & Chemicals Philipp Corp. mined and processed fuller's earth for absorbent uses, fillers for insecticides and fungicides, filters for oils and greases, and drilling mud.

De Kalb.—Tonnage and value of crushed granite were higher than in 1962; however, dimension granite although up 11 percent in quantity was 1 percent lower in value. Producers of crushed granite were Consolidated Quarries Division of Georgia Marble Co., Davidson Granite Co. Inc., and Stone Mountain Grit Co.; dimension granite, Coffey Granite Co., Davidson Granite Co. Inc., J. T. Reagan Granite Co., and Stone Mountain Granite Corp. Sand and Gravel Pit Co. and Stamps Sand Co. mined building and paving sand. Consolidated Quarries Division also marketed a 60–40 percent feldspar-quartz mixture for glass manufacture.

Dooly.—American Mines, Inc., was the only producer of iron ore in 1963.

Dougherty.—Albany Lime & Cement Co., Dawes Silica Mining Co. Inc., and Musgrove Sand Co. mined sand for building and other uses.

Douglas.—Consolidated Quarries Division of Georgia Marble Co. quarried and crushed granite for concrete, roadstone, railroad ballast, and other uses.

Effingham.—Dawes Silica Mining Co. Inc. produced building, blast, filter, and molding sands and fertilizer filler.

Elbert.—Production of dimension granite, all for monumental stone, increased 9 percent in tonnage but decreased 19 percent in value. The decrease was caused in part by a lower unit value of rough monumental stone ($1.85 per cubic foot compared with $1.95 in 1962) and a smaller reported production of higher valued dressed monumental stone. Thirteen companies operated 15 granite quarries, 13 of which produced rough monumental stone only, while 2 produced both rough and dressed stone. Coggins Granite Industries, Inc., Comolli Granite Co., Continental Granite Co. Inc., and Elberton Granite Industries, Inc., were the largest producers in terms of tonnage. McLanahan Crushed Stone Co. quarried and crushed granite for concrete, roadstone, and other uses.

Evans.—Evans Concrete Products Co. mined building sand for its own use at Daisy.

Fannin.—Willingham–Little Stone Co., Division of Georgia Marble Co. quarried and crushed limestone at Mineral Bluff for concrete, roadstone, and agricultural use. A small quantity of gem material (staurolite) was collected.

Fayette.—Tyrone Rock Division of Dixie Lime & Stone Co. produced crushed granite for concrete and roadstone.

Floyd.—American Cyanamid Co. mined bauxite and kaolin from the New Holland mine. Limestone was quarried and crushed at Rome by Ready-Mix Concrete Co. for concrete and roadstone, agstone, railroad ballast, and riprap and by Floyd County Highway Department for roadstone. Oconee Clay Products Co. mined shale for use in its clay products plant at Milledgeville. A small quantity of jasper and quartz was collected for mineral specimens.

Franklin.—Two new companies reported initial production, Eastern Contractors (paving sand) and Rock Products, Inc. (paving gravel).

Fulton.—Southern Cement Co. placed its new $18 million, 1.4-million-barrel cement mill in operation in June. The company mined miscellaneous clay from a pit adjacent to the cement plant and shipped waste marble from Pickens County and limestone from a company quarry in Alabama for use in the mill. Atlanta Brick & Tile Co. and Chattahoochee Brick Co. mined miscellaneous clay for manufacture of brick. Hitchcock Corp. and Stockbridge Stone Division of Vulcan Materials Co. quarried and crushed granite for concrete and roadstone. W. J. Griffins, C. J. Ross, Stamps Sand Co., and Thompson Bros. Sand Co. mined building sand for local use. Zonolite Division of W. R. Grace & Co. exfoliated crude imported vermiculite at Atlanta.

Gilmer.—Willingham-Little Division of Georgia Marble Co. mined and crushed marble for terrazzo and other uses.

Glynn.—Gray Towing Co. produced building sand at Brunswick. Bestwall Gypsum Co. calcined imported crude gypsum for wallboard and other building materials. Brunswick Pulp & Paper Co. calcined mill sludge to lime for recirculation in the papermaking process.

Gordon.—Plainville Brick Co. mined shale for making brick at Plainville.

Greene.—Southeastern Minerals mined quartz at the Poss mine for riprap. L. C. Curtis & Sons mined sand and gravel for building, paving, and other uses.

Gwinnett.—Stockbridge Stone Division of Vulcan Materials Co. and the State Board of Corrections quarried and crushed granite for concrete and roadstone.

Hall.—Gainesville Stone Co. quarried and crushed granite for concrete, roadstone, and riprap.

Hancock.—Middle Georgia Quarrying Co. produced dimension granite for rough monumental stone and rubble, and Weston & Brooker Co. quarried and crushed granite for concrete and roadstone.

Haralson.—Except for a few mineral specimens collected, there was no mineral production.

Hart.—Funkhouser Mills Division of The Ruberoid Co. mined mica schist and produced ground mica at Hartwell for roofing, joint cement, and wallboard.

Henry.—Stockbridge Stone Division of Vulcan Materials quarried and crushed granite for concrete, roadstone, and railroad ballast.

Houston.—Penn-Dixie Cement Corp. mined miscellaneous clay and limestone and manufactured portland cement at Clinchfield. Georgia Limerock Division of Dixie Lime & Stone Co. produced crushed limestone for agricultural use. Lees Sand & Dredge Co. mined paving sand at Perry.

Jasper.—The Feldspar Corp. mined feldspathic rock from several locations and produced flotation-grade feldspar at its Monticello mill. A small quantity of feldspar and quartz for mineral specimens was also collected.

Jefferson.—Georgia-Tennessee Mining & Chemical Co. mined and processsed fuller's earth near Wrens for absorbent uses.

Jones.—Hitchcock Corp. (Gray quarry) and Weston & Brooker Co. (Ruby quarry) mined crushed granite for concrete and roadstone.

Lamar.—Tyrone Rock Division of Dixie Lime & Stone quarried granite at Yatesville for concrete and roadstone.

Lincoln.—Aluminum Silicates, Inc. began production of kyanite at a new mine and mill at Graves Mountain near Lincolnton. A small quantity of rutile for mineral specimens was collected.

Long.—Dawes Silica Mining Co., Inc. mined building sand at Ludowici.

Lowndes.—Lake Park Peat Moss Co. and Georgia Peat Moss Co. produced humus peat for horticultural and agricultural use. Owens-Illinois Glass Co. produced and recirculated lime by calcining pulpmill sludge at its papermill at Valdosta.

Lumpkin.—Lester Grindle produced building sand and gravel for local use at Dahlonega.

Macon.—American Cyanamid Co. mined refractory-grade kaolin at the Cavender bauxite mine near Montezuma.

Madison.—Coggins Granite Industries, Inc. quarried rough monumental granite at the Piedmont quarry.

Mitchell.—Bridgeboro Lime & Stone Co. quarried and crushed limestone for concrete, roadstone, and agricultural uses.

Montgomery.—R. W. Geiger mined building and paving sand at Mount Vernon.

Murray.—Georgia Talc Co. mined crude talc at the Georgia and Lindsey mines near Chatsworth and marketed ground talc for asphalt filler, insecticides, roofing, rubber, and other uses.

Muscogee.—Brown Sand & Gravel Co., Inc. and Calhoun Sand & Gravel Co. produced building and paving sand and gravel. Stockbridge Stone Division of Vulcan Materials Co. crushed granite at the Barin quarry north of Columbus for concrete and roadstone, railroad ballast, and riprap.

Oglethorpe.—Liberty Granite Co. quarried dressed monumental stone, and nine companies produced rough monumental granite. Leading producers of rough monumental stone in terms of tonnage were American Granite Quarries, Inc., Dixie Granite Co., and Hoover Granite Industries, Inc.

Paulding.—A minor quantity of sulfate minerals were collected for mineral specimens.

Pickens.—The county continued as the third county in value of mineral production. Georgia Marble Co. quarried dimension marble (Tate and Nelson Divisions) for dressed building and monumental stone, and crushed marble (Calcium Products Division, New York mine, and Willingham-Little Division, Cove Mountain mine) for whiting, terrazzo, and other uses. Marble Products Co. of Georgia also mined and crushed marble at the Whitestone mine for whiting, terrazzo, and other uses. Carl Johnson, Hardy Johnson, and North Georgia Stone Co. quarried sandstone for rough architectural stone and flagstone.

Polk.—Marquette Cement Manufacturing Co. produced portland and masonry cements at Rockmart from clay and sandstone produced in Polk County and Limestone quarried by the company in Bartow County. Georgia Lightweight Aggregate Co. mined and expanded slate for lightweight aggregate at Rockmart. Gammage Mining Co., and Price & Albea mined brown iron ore.

Rabun.—At Dillard, Rabun Quarries, Inc., crushed granite for concrete and roadstone.

Richmond.—Albion Kaolin Division of Interchemical Corp. mined kaolin for refractories, fillers, chemicals, and other uses. Georgia-Carolina Brick & Tile Co., Georgia Vitrified Brick & Clay Co., and Merry Bros. Brick & Tile Co. mined miscellaneous clay for brick and other clay products. Superior Stone Co. Division of Martin Marietta Corp. quarried and crushed quartzite for concrete and roadstone at the Dan quarry north of Augusta. Speer Sand & Gravel Co. mined building sand. Continental Can Co. calcined papermill sludge to lime for recirculation through its mill at Augusta.

Stewart.—Brown iron ore was produced by five companies, compared with three in 1962: Brown-Nuggett Mining Co., Dunbar and Layton, Howell and Chandler, Lumpkin Mining Co., and Stewart Mining Co.

Sumter.—American Cyanamid Co. mined both bauxite and kaolin from the Easterlin, Holloway, and Thigpen mines.

Talbot.—Brown Bros. Sand Co. and Taylor Sand Co. mined building, paving, and other sands.

Taylor—Butler Sand Co. and Howard Sand Co. mined building and paving sand.

Telfair.—Flanders Bros. mined building sand near Scotland.

Thomas.—Cairo Production Co., Inc. and Waverly Petroleum Products Co. mined and processed fuller's earth for absorbent uses. Dawes Silica Mining Co., Inc. mined sand for building, glass, filter, ground sand and flour, and other industrial sands.

Towns.—Amethyst, corundum, and quartz for gem material and mineral specimens were collected by J. M. Stoinoff.

Troup.—Several individuals collected beryl and rose quartz as mineral specimens.

Twiggs.—The county continued to rank first in value of mineral production, totaling $27.1 million, 12 percent more than in 1962. Freeport Kaolin Co. (formerly Southern Clays, Inc.), Georgia Coating Clay Co., Georgia Kaolin Co., and J. M. Huber Corp. mined and processed kaolin for many uses. Stephens Fire Brick Co. mined refractory kaolin for fire brick and block. The Diversey Corp. mined and processed fuller's earth for filtering and clarifying, absorbents, insecticides, fungicides, and other uses.

Walker.—General Shale Products Corp. mined shale for shipment to its Chattanooga, Tenn., brick plant. Georgia Limestone Co., Patton Rock Products Corp., and Rossville Crushed Stone Co. crushed limestone for concrete, roadstone, and other uses. H. R. Perry Stone Co. was a new producer of dimension limestone for rough architectural uses. W. T. Blevins Coal Co.'s Walden mine was the only active coal operation in the State. A small quantity of agate was collected for mineral specimens.

Ware.—E. W. Pafford mined building sand near Waycross.

Warren.—Weston & Brooker Co. quarried and crushed granite at Camak for concrete, roadstone, riprap, railroad ballast, and other uses.

Washington.—The county ranked second in value of mineral production with a total of $17.8 million, 10 percent more than in 1962. Kaolin, the only mineral produced, was mined and processed by American Industrial Clay Co., Anglo-American Clays Corp., Champion Paper & Fibre Co., Minerals & Chemicals Philipp Corp., Thiele Kaolin Co., and United Clay Mines Corp. The kaolin was sold principally for paper coating and filling; other uses were whiteware, tile, refractories, plastics, paint, rubber, fertilizer, and catalysts.

Wayne.—Rayonier, Inc., calcined sludge and recirculated the resulting lime in its cellulose plant at Jesup.

Webster.—Davis Bros. was the only active brown iron ore producer.

White.—Western Stone Co., Inc. was a new producer of paving gravel.

Whitfield.—Dalton Rock Products Co. quarried and crushed limestone for concrete, roadstone, and agricultural use.

Wilkinson.—Kaolin, the only mineral produced in the county, was mined by Evans Clay Co., M & M Clays Co., and Minerals & Chemicals Philipp Corp., principally for paper coating and filling, paint, and rubber; and by D. C. Hardie Clay Co. and Oconee Clay Products Co. for fire brick, block, and other refractories.

The Mineral Industry of Hawaii

This chapter has been prepared under a cooperative agreement for collecting mineral data between the Bureau of Mines, U.S. Department of the Interior, and the Hawaii Department of Land and Natural Resources.

By Roy Y. Ashizawa [1]

EXCEPTIONALLY heavy and sustained rainfall during the first half of 1963, and labor disputes during the last half, adversely affected Hawaii's construction industry, the principal consumer of mineral materials produced in the State. The rise in value of mineral output to $15.3 million from $14.8 million in 1962, was due solely to increased sales of cement. Of the 1,483,000 barrels of cement shipped from plants on Oahu Island, 490,000 barrels was exported. Consumption of cement in Hawaii was nearly 12 percent less than in 1962. The combined out ut of quarried stone and natural sand and gravel totaled 4,148,000 tons, compared with 4,771,000 in 1962, a decrease of 13 percent.

Sales of lime to sugar mills and pineapple canneries remained virtually unchanged, but demand for calcined agricultural lime dropped as consumers used dredged coral as a substitute. The rainy weather affected the production of solar-evaporated salt and hampered the mining of clay. Sugarcane and pineapple plantations were compelled to use increased tonnages of volcanic cinder to repair their haul roads.

TABLE 1.—Mineral production in Hawaii [1]

Mineral	1962		1963	
	Quantity	Valve (thousands)	Quantity	Value (thousands)
Cement—376-pound barrels	1,128,304	$6,055	1,482,845	$7,125
Gem stones	(2)	(3)	(2)	36
Lime—short tons	15,243	386	12,056	423
Pumice (volcanic cinder)—do	231,922	380	273,851	469
Sand and gravel—do	700,196	1,122	304,367	764
Stone—do	4,071,186	6,883	3,844,000	6,480
Value of items that cannot be disclosed: Clays, salt and values indicated by footnote 3		18		5
Total		14,844		15,307

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Figure withheld to avoid disclosing individual company confidential data.

[1] Mineral specialist, Bureau of Mines, San Francisco, Calif.

Appreciable quantities of black coral gem material were gathered for the growing tourist trade.

Employment and Injuries.—Preliminary reports received from Hawaii's mineral producers showed that an average of 595 employees, excluding office workers, worked 1,053,000 man-hours in 1963, compared with final figures of 685 employees and 1,150,000 man-hours in 1962. Two fatalities and 32 nonfatal lost-time injuries were reported in 1963; no fatal and 55 nonfatal injuries were reported in 1962. Both fatalities in 1963 involved bulldozer operators at stone quarries, one on Oahu and the other on Hawaii.

Legislation and Government Programs.—Act 11 of the 1963 State Legislature further amended Title 12 of the Revised Laws of Hawaii 1955, by adding a new chapter numbered 99A relating to mineral rights, providing for the reservation of such rights to the State in State lands, the lease of such rights and the payment of rentals and royalties therefor, and the regulation of strip mining. Minerals, as defined under Section 99A–1, does not include sand, rock, gravel, and other materials suitable for use in road construction.

Water—Dried-up wells, polluted lakes and streams, and water wasted to the sea, have caused serious and critical water shortages in many areas of the United States. In recent years, as in the case of Oahu's restrictions on mining of beach sand and volcanic cinders, the encroachment of urban development and the depletion of ore reserves have compelled many U.S. producers to move their mining operations to mineral deposits distant from their marketing area and public water supply.

The Bureau of Mines conducted a special national survey in mid-1963 to obtain 1962 basic data on the type, source, use, and disposal of water at the site of each pit, quarry, and integrated raw-mineral washing plant. The survey was confined to mining operations. Thus, in the case of Hawaii, cement, lime, solar salt, and gem material operations were excluded. Detailed information was not required from operations using less than 1 million gallons of water per year.

The total new water intake at all of the mining operations in Hawaii in 1962 amounted to 328 million gallons. Each of the clay, pumice, volcanic cinder, and sand and gravel operations in Hawaii either had less than 1 million gallons of water intake at the site, or transported water to the site. New water intake of over 1 million gallons occurred only at commercial basalt and limestone quarry operations, from which detailed data were obtained and combined as follows: 326 million gallons of intake, of which 209 million gallons was used for washing the crushed stone and any accumulated rain-soaked mud from the crushers; 117 million gallons was used for equipment coolant, drinking, and sanitary purposes. Less than 1 percent of the intake was consumed, evaporated, or lost with the products; 325 million gallons was discharged and none was recirculated. Virtually all of the moisture in the products at wet-processing operations drained into the ground, stream, or ocean before the products were hauled away from the site.

Of the 326 million gallons of new water intake, 26 million was fresh water purchased from public water supplies; 39 million gallons was salt water pumped from the ocean; and 261 million gallons was

brackish well water or contaminated stream water not suitable for domestic use.

Discharge water was disposed of as follows: 23 million gallons to public or privately owned sewerlines, and 302 million gallons to the ground, streams, and ocean. To minimize pollution, the quarry operators transferred 218 million gallons of the discharge water to settling ponds before disposal to the ocean or streams. The remaining 107 million gallons was disposed of without treatment.

All of the respondents in Hawaii included in this survey who used 1 million or more gallons of water per year declared that their water supply was adequate for the present and foreseeable future (10 to 20 years). They constituted 7 percent of the respondents. The other 93 percent transported or had water intake at the site of less than 1 million gallons each.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Plants on Oahu produced 1,428,000 barrels (376 pounds) of cement and shipped 1,483,000 barrels to the following customers: 47 percent to ready-mixed concrete companies, 31 percent to government agencies, 12 percent to building material dealers, 8 percent to concrete-product manufacturers, and 2 percent to contractors and miscellaneous customers. Nearly 490,000 barrels were exported, mainly to South Korea, and 993,000 barrels were shipped for use in the State. Total consumption of cement in Hawaii, including special cements received from the U.S. mainland, was 995,000 barrels in 1963, or 134,000 barrels less than in 1962.

Nearly 794,000 barrels of cement was shipped from the plants in bulk, and 689,000 barrels in paper bags. Cement raw materials from local sources were 318,000 tons of coral limestone and 65,000 tons of basalt and trachyte. Over 33,000 tons of imported silica sand, gypsum, and grinding aids also were consumed at the plants. Hawaiian Electric Co., Ltd., supplied the two plants with 36.8 million kilowatt-hours of steam-generated electrical energy during 1963.

Clays.—Clay was mined at the Wilson pit near Waimanalo on Oahu and hauled to stockpiles maintained at the Hawaii Clay Products, Inc., plant at Barbers Point. The company used the Waimanalo and previously stockpiled clay from Kaneohe to make brick, tile, and flower pots. Beginning in November, following receipt of a pipe extruder from the mainland, Waimanalo clay was used to make vitrified sewer pipe. Pending completion of plans to install a 212-foot tunnel kiln, the company erected a scove kiln to supplement its periodic down-draft kiln.

Gem Stones.—Increased tourist trade resulted in a greater demand for Hawaii's black coral jewelry items. Scuba divers gathered the black gem material from the deep underwater canyons in the channels near Maui Island. The raw black coral was sold to lapidaries and jewelry manufacturers on Oahu, Maui, and Hawaii. A manufacturer on Oahu added goldsmithing to its silversmithing operations to expand the market for its black coral jewelry. Souvenir shops sold other gem jewelry identified as Pele's Tears, Maui Moonstone, and

Hawaiian Olivine. The sources of these gem materials were closely guarded by suppliers in Hawaii. The size, color, and characteristics of the gems were similar to the Apache tears, Arizona moonstone, and olivine collected in Arizona and New Mexico.

Lime.—Output of lime at two plants, one on Oahu and one on Maui, declined from 15,243 tons in 1962 to 12,056 tons in 1963. The drop occurred mainly in the agricultural lime sales, apparently because of increased output of agricultural limestone produced from surplus stockpiles of coral dredged from Hawaii's deep water harbors. Sales of mason's lime were 2 percent below those of 1962. Although small in terms of tonnage, the volume of lime sold for use in food and food byproducts increased.

Pumice (Volcanic Cinder).—Nearly 274,000 tons of pumice, volcanic cinder, and volcanic ash was produced in 1963, compared with 232,000 tons in 1962. Of the total, 74 percent was used for road construction and maintenance, and the remaining 26 percent for lightweight concrete aggregate, roofing granules, and decorative purposes. Most of the output came from the island of Hawaii, where 207,000 tons was mined. Appreciable quantities of black cinder from Makiki Heights on Oahu, and of an unusually bright rust-colored cinder from Hawaii were used locally by home owners and subdivision developers for driveways and decorative fill. Interisland barge shipments of lightweight concrete aggregate to Oahu consisted of cinders from Waieli, Molokai Island, and pumice from Puuwaawaa, Hawaii Island.

Salt.—Solar evaporated salt was produced from seawater at a small commercial facility at Keehi lagoon on Oahu. Intake of the seawater from the lagoon to the concentrating ponds was by pump or by gravity flow during high tide. The brine was then transferred through a series of ponds into 20- by 20-foot crystallizing ponds. The crystallized salt was harvested by wheelbarrow, washed, bagged, and sold undried to local grocers. Solar salt also was produced by individuals and clans throughout the islands at a number of backyard operations, including a fairly sizable one at Salt Pond near the Port Allen airport on Kauai Island. There, each individual or clan staked off an area within the pond to produce salt for consumption or sale to friends. Hawaii's crude salt and medium-grade undried crude salt from the mainland were used in generous amounts to season fish, beef, and pork, particularly the Kalua pig served at luaus.

Sand and Gravel.—Beach and dune sands and streambed sand and gravel totaling 304,000 tons were produced in 1963. Sand comprised the major portion of the total output. The facility at Papohaku Beach on Molokai continued to be the principal source of sand used in concrete aggregate. Most of the pineapple and sugar plantation operators mined their own requirements of sand from beach, dune, and stream deposits for use in constructing ditches, culverts, and flumes. Substantially less basaltic gravel and boulders were used during the year, because of changes in the sites of road construction and maintenance projects. Principal producers of waterborne gravels operated plants near Waikapu on Maui Island, and Kalihiwai on Kauai Island.

Stone.—The total volume of quarried stone sold or used by commercial producers and government crews and contractors amounted to 3.8 million tons. The quantity was 227,000 tons less than in 1962.

Seventy percent of the total output was produced on Oahu. Production on Hawaii was 927,000 tons, a gain of 182,000 tons. The output was mainly miscellaneous volcanic rocks used as road base at highway and subdivision projects. Output from Kauai and Maui was up 71,000 tons. Stone production on Molokai remained virtually unchanged.

Quarries yielded 2,220,000 tons of basalt, 817,000 tons of coral limestone, and 807,000 tons of miscellaneous stone. Eighty percent of the total was processed for use as concrete aggregate and roadstone. The remainder consisted of lava slabs, one-man stone, riprap, railroad ballast, roofing granules, stone sand, and limestone used for agricultural liming and for making cement and lime.

Vermiculite.—A small vertical furnace was operated on Oahu to expand crude vermiculite shipped from Libby, Mont. The exfoliated product was sold for use as thermal and sound insulation, lightweight plaster and concrete aggregate, and soil conditioner.

MINERAL FUELS

Large quantities of aviation and automobile gasolines, chemicals, and other products from petroleum were produced at the refinery of the Standard Oil Co. of California, Barbers Point, Oahu. Supertankers carrying crude oil from distant foreign oilfields pumped their cargo through 12,000 feet of underwater pipe extending from an offshore anchorage to the refinery's storage tanks, which had a crude storage capacity of nearly 1.25 million barrels. Five of the tanks had a capacity of 242,000 barrels each, reportedly among the largest floating-roof tanks in the world.

REVIEW BY ISLANDS

Hawaii (Hawaii County).—James W. Glover, Ltd., produced basalt at its Hilo quarry and aa rock adjacent to the Hilo airport for concrete aggregate and base material. The company hauled volcanic cinders from Kapoho and dredged coral from Kawaihae Harbor to Hilo for use in lightweight concrete blocks. Glover also made test openings at two quarry sites near Hilo as possible sources of large armor stone for the proposed tidal-wave barrier at Hilo Harbor. Kuwaye Bros., Inc., and Yamada & Sons, Inc., two of the island's principal contractors, operated portable crushers and loaders at various volcanic rock and cinder deposits. Some of the dredged coral stockpiled at Kawaihae Harbor was processed by Yamada, as well as by Kawaihae Products, Inc., of Kamuela, for agricultural liming. The latter company also crushed coral for use as concrete aggregate. Contractors at the nearby Mauna Kea (Kaunaoa) beach resort development used dredged coral for construction of access roads and for creating a seed bed for a championship golf course being built on rough volcanic lava.

The Kohala Mountain cinder pit, on the west side of Highway 25 between Kamuela and Hawi, was the principal source of road material used by public works crews in the north coast area. At Hawi, Kohala Sugar Co. used bulldozers and diesel shovels to obtain miscellaneous clinker rock from the Niulii and Iole quarries. Some of the material

TABLE 2.—Value of mineral production in Hawaii, by counties

County	1962	1963	Minerals produced in 1963 in order of value
Hawaii	$1,774,610	$1,510,663	Stone, pumice (volcanic cinder), sand and gravel.
Honolulu	11,771,417	12,411,243	Cement, stone, lime, sand and gravel, pumice (volcanic cinder), salt, clays.
Kauai	284,065	383,577	Stone, sand and gravel, pumice (volcanic cinder).
Maui	1,012,830	1,001,386	Sand and gravel, stone, lime, pumice (volcanic cinder), gem stones.
Total	14,844,000	15,307,000	

was used to maintain plantation roads; some was hauled to a small stationary crusher in Honomakau Gulch.

Volcanite, Ltd., quarried pumice, commercially identified as trachyte, from an unconsolidated deposit at Puuwaawaa. The aggregate was crushed and screened, and hauled to batch concrete plants on the island or shipped by barge from Kawaihae Harbor to Oahu. Near Keauhou, southeast of Kailua-Kona, J. M. Tanaka Contractors, Inc., operated a batch concrete plant utilizing basalt and aa rock quarried nearby. The company was also the prime contractor for the first increment of the Chain of Craters road at Hawaii Volcanoes National Park, utilizing aa rock obtained near Kalapana for the project. Maintenance crews at the National Park used miscellaneous lava rocks from a quairry near Bird Park, northwest of the Kilauea Crater, and from a pit n the Kau Desert, south of the crater. In order to preserve the desertscenery, the pit and the stationary crusher in the pit were hidden behind a large artificially created mound of volcanic material.

Substantial quantities of volcanic cinders and clinkers, used to construct and maintain haul roads, were quarried on sugar plantation lands near Naalehu, Pahala, and Keaau, and between Hilo and Honokaa. Decomposed miscellaneous stone excavated from several pits between Honokaa and Kamuela was used mainly for fill by contractors and cattle ranchers in the area. Beaches along the Kona, Kau, and Puna districts were sources of basaltic sand and gravel produced for local use in concrete and road repair. From the lava flow of 1840, near Pahoa, James Kuwana, Walter Yamaguchi, and others used crowbars and tractors with finger lifts to obtain decorative slabs. The slabs lie under areas of dense tropical vegetation. Large tonnages of volcanic cinders were removed from numerous cones near Kapoho, including the Puu Laimana (Lyman Hill) which was created during Kapoho's 1960 volcanic eruption.

Kauai (Kauai County).—Grove Farm Co., Ltd., produced basalt at its Bluestone quarry near Puhi and at the Kahili quarry near Kilauea, miscellaneous volcanic rocks at the Kapaia Valley quarry near Hanamaulu, and gravel from the Kalihiwai River. The company also withdrew coral limestone and volcanic cinder from stockpiles near Koloa. Streambed gravels from the Kalihiwai River were recovered by Grove Farm with a diesel shovel and transported a short distance to a semiportable crushing and screening plant. The processed gravel was used for constructing the approaches to a new prestressed concrete bridge over the river. The new approach and bridge replaced the old route over a low Bailey bridge which had been erected after the 1957 tidal wave destroyed the previous structure.

The prestressed concrete piles and the 100-foot girders for the new bridge were fabricated on Oahu, barged to Kauai and hauled to the site on two tractors operated in tandem, an unusual sight for the Kamaainas (old timers) of this oldest of the inhabited Hawaiian islands.

Grove Farm operated the Kapaia Valley quarry under a contract from Lihue Plantation Co., Ltd., which exhausted its supply of dredged coral used to construct and maintain its sugarcane haul roads. The 10–C Beach at the Lihue Plantation was the island's principal source of coral sand for concrete. Coral and basaltic sand were produced from other beach deposits, from the mouths of the principal rivers, and from the Field 67 coral sand pit of the Kekaha Sugar Co., Ltd.

Volcanic cinder was produced at the McBryde Sugar Co., Ltd., Kapeku Cinder Hill near Kalaheo, for use as concrete aggregate and fill, and for construction of secondary roads. Olokele Sugar Co., Ltd., at Kaumakani, located and developed a deposit of coarse volcanic cinder suitable for road maintenance. The year's operation at the deposit was confined to the removal of overburden.

Lanai (Maui County).—Construction and maintenance crews at the Dole Corp. pineapple plantation obtained sand near Manele Bay for use as concrete aggregate. The company's requirements of crushed stone were supplied by commercial producers on Oahu.

Maui (Maui County).—Hawaiian Commercial & Sugar Co., Ltd. (HC&S), used coral beach sand to produce hydrated lime at its plant near Lower Paia. The lime was distributed in bulk to sugar mills and in bags to pineapple canneries. Shipments also were made in bags to A & B Commercial Co., at Kahului, for resale to local consumers. During 1963, HC&S improved the efficiency of its lime plant by modifying the drives on the lime elevators. The 22-foot steel smokestack installed at the plant in January 1960 showed signs of corrosion and was scheduled for replacement.

Kahului Railroad Co. quarried basalt rock at its Camp 10 quarry near Puunene, and used jaw, gyratory, and roll crushers, and triple-deck screens to process the material for concrete aggregate and railroad ballast. The company's portable crusher was moved from Lahaina to Camp 10 and used as part of the stationary operation. Maui Concrete & Aggregates, Inc., operated a portable crusher to process gravel obtained from an alluvial deposit in the foothills near Waikapu. The crushed rock and fines were hauled to the company's batch concrete plant at Naska, and to a batch plant at the Pioneer Mill Co. casting yard near Lahaina. The latter company obtained its requirements of volcanic cinder from the Launiupoko and Wahikuli cinder deposits in the Lahaina area.

A & B Commercial Co. produced volcanic cinder at the Puuhele pit near Maalaea for use at its concrete products plant near Puunene. The old Puunene cinder pit was abandoned and is being used as a rubbish dump. Maui Pineapple Co., Ltd., sent crews from its Honolua Division to the Honokohau pit in west Maui for cinder and ash. The Haleakala Ranch Co. Puu Pane cinder pit near Makawao was a source of road base and fill material used mainly by contractors. The Puu Mahoe cinder deposit on lands of the Ulupalakua Ranch, Ltd., was idle. County road crews obtained gray cinders at Puu Pimoe near the abandoned Kanaio Prison Camp. The county agency maintained

747-416—64——22

a portable crusher at Hana to process beach gravels and cobbles periodically for use in the area. Crews at Haleakala National Park used a small quantity of black cinder from near Red Hill for patching roads. Sand was produced from beach and dune deposits for use in structural concrete and road repair.

Charles Brugman, Mike King, George Pimental, Neal Tobin, and Ivan Young were among the scuba divers who collected black coral gem material from the deep channel waters between Maui, Lanai, and Molokai. Some of the raw coral was sold locally to Jack Ackerman's Maui Divers, Lahaina, for use in making Hawaiian jewelry.

Molokai (Maui County).—Honolulu Construction & Draying Co., Ltd., made extensive improvements to its Papohaku Beach sand harvesting and loading facility which was virtually destroyed by a storm in December 1962. A slack-line cable dragline was re-erected over a new concrete truck tunnel for use in stockpiling and loading sand onto a fleet of bottom-dump trailers. The company also continued to produce volcanic cinder from the Waieli deposit. Both the sand and cinder were hauled to Lono Harbor for barge transshipment to Oahu Island.

Molokai Aggregates, Inc., supplied virtually all of the concrete aggregate and roadstone used on the island. The company quarried and processed basalt rock at Manawainui and obtained coral dune sand from Moomomi. The Moomomi dunes were also worked by contractors and public works crews for their sand requirements. Most of the volcanic cinder produced at the Puuluahine cinder pit was used for maintenance of roads, including those in the Kalae area near Phallic Rock. Some of the streambed gravel, referred to locally as iliili, from the gulches east of Kaunakakai was used for road shoulders and driveways.

Oahu (Honolulu County).—Hawaiian Cement Corp. with a dry-process plant at Barbers Point, and Permanente Cement Co. with a wet-process plant at Waianae, shipped portland cement valued at $7.1 million, or 57 percent of the value of the mineral output in Honolulu County. Stone quarries on Oahu yielded over 1.9 million tons of basalt, 758,000 tons of limestone, and nearly 12,000 tons of miscellaneous stone, a total of 2.7 million tons, 480,000 tons less than in 1963.

Basalt was quarried by HC&D, at the Kapaa quarry near Kailua. The company also sold and used coral sand and lightweight volcanic cinder barged to Oahu from its Molokai Island facility. Hawaiian Bitumuls & Paving Co., Ltd., produced basalt at the Kaena quarry for road base and asphaltic concrete aggregate. The Kolekole basalt quarry near Schofield Barracks was idle during 1963. Nanakuli Paving and Rock Co., Ltd., worked its Testa limestone quarry most of the year. Coral operations of Oahu Aggregates, Inc., at Barbers Point were confined to processing stockpiled material. On July 31, Oahu Aggregates was dissolved and operations absorbed by HC&D and Hawaiian Bitumuls & Paving Co. In December, the primary crusher was dismantled and shipped for use at Hawaiian Bitumul's operations on Guam, which had been virtually leveled by a typhoon in 1962.

Pacific Cement & Aggregates, Inc., quarried basalt rock at the Halawa quarry near Aiea, and limestone at the Lualualei quarry.

Basalt was quarried and processed by Pacific Concrete & Rock Co., Ltd., at its Palailai quarry and limestone, at its Kailua quarry. Coral limestone was mined by Ewa Plantation Co. at pits near Ewa, Kahuku Plantation Co. at its Malaekahana quarry, Hawaiian Cement Corp. at Barbers Point, and Permanente Cement Co. at Waianae. Public works crews and several contractors utilized an appreciable quantity of coral which had been cleared from the harbors and offshore reefs.

Joe's Moss Rock Co. and Stanley Contracting, Inc., were principal suppliers of decorative rock gathered in the Waianae area. Road aggregate for Schofield Barracks was purchased from commercial producers and from the U.S. Navy coral stockpile. A substantial volume of volcanic cinder from Makiki Heights was removed by I. Doi Trucking Co. and sold for use mainly as cushion material for pipes and concrete slabs.

Hydrated lime was produced at the Waianae lime plant operated by GasprO, Ltd., utilizing coral limestone. Toward the end of the year, the company began purchasing limestone from Nanakuli Paving and producing lime that was finer in particle size and higher in calcium content.

Hawaii Clay Products, Inc., the State's sole manufacturer of clay products, used clays from Waimanalo and Kaneohe to produce brick, tile, and pipe at Barbers Point. At the west fringe of the access road to Sand Island, Tamotsu Tanaka produced solar evaporated salt for local consumption. Exfoliated vermiculite was produced by Vermiculite of Hawaii, Inc., Honolulu, for insulation, lightweight aggregate, and agricultural use. Maui Divers of Hawaii, Ltd., which moved its lapidary and jewelry manufacturing facility from Lahaina, Maui, to Honolulu in 1962, was the State's principal buyer of black coral collected by scuba divers from the deep waters off Maui.

The Mineral Industry of Idaho

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Idaho Bureau of Mines and Geology for collecting information on all minerals except fuels.

By Jerry J. Gray,[1] Richard W. Knostman,[1] and Norman S. Petersen[2]

IDAHO mining operations yielded products valued at $82.8 million in 1963, an increase of 0.2 percent over the 1962 figure. In terms of constant dollars (1957–59 base), value decreased 2 percent compared with 1962 data. The difference between the two percentages was due to higher metal prices and lower physical output. The loss in production was due to a labor dispute, a shortage of miners, accelerated development programs, partial closure of a phosphate operation, and smaller requirements for construction materials.

Base-metal and silver mines in Shoshone County supplied 65 percent of the total value of minerals. In order of descending value, mineral commodities comprising nearly all of the State mineral-production total were silver, lead, zinc, sand and gravel, phosphate rock, and copper. Of these six commodities, only two had gains in quantity—copper (8 percent) and zinc (1 percent). Output of silver dropped 1.1 million ounces (6 percent), but owing to a rise in average price from $1.09 (1962) to $1.28 (1963), value increased $2.1 million (11 percent). Production of lead decreased 10 percent, while value, because of a higher price, increased 6 percent. Sand and gravel, cement, and stone output declined 13, 9, and 15 percent, respectively, because of less demand by the construction industry. Curtailment of mine output of phosphate rock was attributed largely to operation by Central Farmers Fertilizer Co. on stockpiled ore and to partial closure of its processing complex in October.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Consumption, Trade, and Markets.—A slowdown in business activity caused most of the annual statistics to show a drop or to remain fairly static. Output of several mineral products declined because of less construction activity. Employment in the construction industry

[1] Geologist, Bureau of Mines, Albany, Oreg.
[2] Mineral specialist, Bureau of Mines, Albany, Oreg.

TABLE 1.—Mineral production in Idaho [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate short tons, antimony content	631	[2]	645	[2]
Clays thousand short tons	35	$70	[3] 31	[3] $15
Copper (recoverable content of ores, etc.) short tons	3,861	2,378	4,172	2,570
Gold (recoverable content of ores, etc.) troy ounces	5,845	205	5,477	192
Iron ore (usable) thousand long tons	5	35	6	40
Lead (recoverable content of ores, etc.) short tons	84,058	15,467	75,759	16,364
Lime thousand short tons	68	801	60	874
Phosphate rock thousand long tons	1,912	10,635	1,700	10,589
Pumice thousand short tons	[4] 67	[4] 103	161	275
Sand and gravel do	14,321	13,029	12,433	10,615
Silver (recoverable content of ores, etc.) thousand troy ounces	17,772	19,283	16,711	21,375
Stone thousand short tons	1,381	2,698	1,168	2,217
Zinc (recoverable content of ores, etc.) short tons	62,865	14,459	63,267	14,551
Value of items that cannot be disclosed: Barite, cement, clays (fire clay, kaolin, and bentonite), garnet (abrasive), gem stones, mercury (1963), mica, peat, perlite, titanium, uranium ore (1962), vanadium, and values indicated by footnote 2	----------	3,451	----------	3,078
Total	----------	[4] 82,614	----------	82,755

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Excludes certain clays; included with "Value of items that cannot be disclosed."
[4] Revised figure.

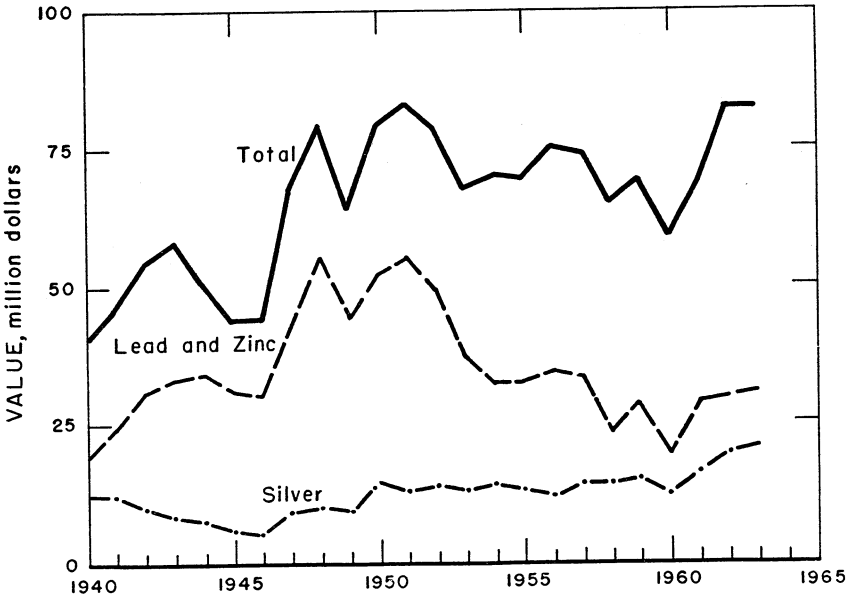


FIGURE 1.—Value of silver, lead and zinc, and total value of mineral production in Idaho, 1940–63.

dropped 24 percent, mainly because of the 1962 completion of construction at the Mountain Home Missile Base. Mobility of construction workers caused a contradiction in employment statistics;

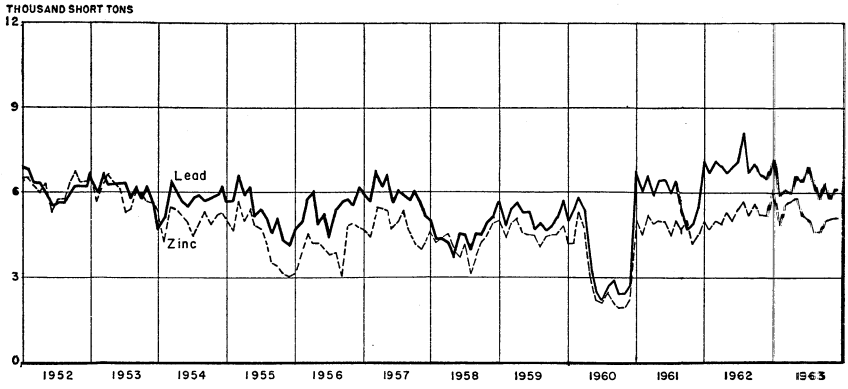


FIGURE 2.—Mine production of lead and zinc in Idaho, 1952–63, by months in terms of recoverable metals.

both employment and unemployment were less. The value of State highway contracts awarded and the value of contract work completed decreased 9 and 12 percent, respectively. Building-permits value increased less than 1 percent (compared with 6 percent nationally). The indicator with the greatest fall, 22 percent, was heavy engineering awards. Per capita personal income declined 0.1 percent, compared with a national advance of 3.2 percent.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$81,961	1958	$57,666
1953	69,080	1959	69,119
1954	71,159	1960	55,299
1955	62,734	1961	67,719
1956	64,176	1962	79,353
1957	71,849	1963	78,142

J. R. Simplot Co. announced a $10 million expansion program which was to double the phosphate-fertilizer-production capacity at the Pocatello works. Kermac Nuclear Fuels Corp. completed constructing a 750-ton-per-year vanadium pentoxide recovery plant near Soda Springs. The raw material was to be byproduct ferrophosphorus from the nearby Monsanto Chemical Co. elemental phosphorus operation. Output of vanadium declined sharply compared with the previous year's total.

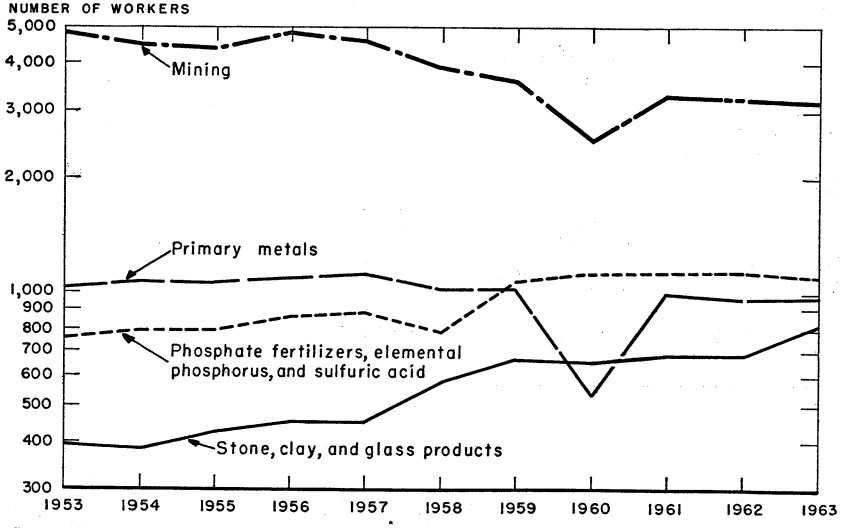
Gold output dipped to the lowest point on record. Mica mine output was recorded for the first time since 1959.

Employment and injuries.—According to the Idaho Employment Security Agency, the number of workers in manufacturing stone and clay products increased substantially; only small gains were recorded for mining in nonmetals and fuels. Employment in primary-metal processing remained steady. Metal mining and industrial chemicals (phosphate fertilizer, elemental phosphorus, and sulfuric acid) employment declined 2.3 and 3.0 percent, respectively. Mining firms

were recruiting miners as far away as Duluth, Minn., but because of a labor dispute average monthly metal mining employment was less. Employment statistics, also, reflected the closure of phosphate plants.

Legislation and Government Programs.—The Office of Minerals Exploration signed exploration contracts with Congdon and Carey (Boise County, molybdenum), Clayton Silver Mines (Custer County, silver), and J. Howard Sims (Lemhi County, silver and gold). The contracts totaled $213,850; Government participation was 50 percent.

The 1963 Idaho State Legislature created an Idaho Oil and Gas Conservation Commission. The Commission membership was to be identical with that of the Board of Control of the Idaho Bureau of Mines and Geology.



Source: Idaho Employment Security Agency.

FIGURE 3.—Employment Trends, 1953–63.

Water.—The results of a Bureau of Mines 1962 survey of water requirements (exclusive of smelters, refineries, and cement plants) for the mineral industry in Idaho showed that approximately 11.9 billion gallons of water was required for mining and processing. Approximately 77 percent of the total was required for metal mining and processing (excluding smelter operation); 19 percent for nonmetal mines and mills (excluding cement plants); and 4 percent for sand and gravel and stone-quarrying operations.

Approximately 97 percent of the new-water requirement was eventually returned to the source or discharged; water consumed in products or evaporated totaled 334 million gallons.

Recirculated water accounted for 72 percent of the water requirements for nonmetal mines and mills as opposed to only 3 percent for metal mining and processing operations. Sand and gravel and quarrying operations reported no water recirculated.

TABLE 3.—Indicators of Idaho business activity

		1962	1963 [1]	Change, percent
Personal income:				
Total	millions	$1,355.0	$1,379.0	+1.8
Per capita		$1,936.0	$1,934.0	−.1
Construction activity:				
Building permits	millions	$38.0	$38.1	+.3
Heavy engineering awards	do	$60.7	$47.3	−22.1
State highway commission:				
Value of contracts awarded	do	$26.6	$24.1	−9.4
Value of contract work performed	do	$29.9	$26.3	−12.0
Cement shipments to and within Idaho	thousand 376-pound barrels	1,090.9	1,141.5	+4.6
Cash receipts from farm marketings	millions	$429.0	$446.8	+4.1
Mineral production	do	$82.6	$82.8	+.2
Factory payrolls	do	$161.4	$169.4	+5.0
Annual average labor force and employment:				
Total labor force	thousands	266.9	266.2	−.3
Unemployment	do	14.8	14.6	−1.4
Employment:				
Construction	do	11.5	8.7	−24.3
Food processing	do	11.2	11.1	−.9
Lumber	do	11.0	11.5	+4.5
All manufacturing	do	31.7	32.3	+1.9
All industries	do	252.0	251.5	−.2

[1] Preliminary figures.

Sources: Survey of Current Business, Construction Review, Pacific Builder and Engineer, Idaho State Highway Commission, The Farm Income Situation, Idaho Labor Market, Labor Force and Employment in Idaho, Distribution by Industry of Wages Paid for Covered Employment in Idaho, and Bureau of Mines.

TABLE 4.—Annual employment and wages paid in the mineral industries

Year	Mining							
	Metals		Nonmetals		Fuels		Total	
	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)
1959	3,305	$18,393	292	$1,379	20	$127	3,619	$19,899
1960	2,282	13,550	235	1,187	20	132	2,537	14,869
1961	3,032	17,607	288	1,785	2	5	3,322	19,397
1962	2,996	17,336	270	1,546	----------	----------	3,266	18,882
1963 [1]	2,926	17,650	285	1,519	13	84	3,224	19,253

Year	Manufacturing							
	Stone and clay products		Primary metals		Phosphate fertilizers, elemental phosphorus, and sulfuric acid		Total	
	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)
1959	664	$3,228	1,036	$5,656	[2] 1,139	[2] $6,834	2,839	$15,718
1960	654	3,376	534	3,023	1,244	7,991	2,432	14,390
1961	677	3,457	1,008	5,750	1,250	8,263	2,935	17,470
1962	686	3,936	970	5,497	1,254	8,240	2,910	17,673
1963 [1]	823	4,369	971	5,694	1,217	8,342	3,011	18,405

[1] Preliminary figures.
[2] Part of the 1959 gain was due to obtaining greater detail from multi-industry employees.

Source: Idaho Employment Security Agency; employment covered by unemployment insurance. Industry groups may not correspond with those in the Bureau of Mines canvass.

TABLE 5.—Hours and earnings of production workers in mining

Annual average—	1959	1960	1961	1962	1963
Weekly earnings	$101.91	$103.21	$105.32	$107.32	$110.12
Hourly earnings	$2.58	$2.66	$2.62	$2.72	$2.79
Weekly hours	39.5	38.8	40.2	39.4	39.5

Source: Idaho Employment Security Agency.

TABLE 6.—Injury experience in the mineral industries [1]

Year and industry	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1962:						
Quarries and mills [2 3]	271	129	279,637		1	4
Nonmetal mines and mills	620	263	1,304,849	1	24	19
Sand and gravel operations [3]	320	129	330,455	1	3	12
Metal mines and mills	2,638	235	4,964,752	2	429	87
Coal mines						
Total	3,849	223	6,879,693	4	457	67
1963: [4]						
Quarries and mills [2 3]	171	174	238,130		3	13
Nonmetal mines and mills	661	289	1,526,175	2	11	9
Sand and gravel operations [3]	215	133	228,605		2	9
Metal mines and mills	2,592	238	4,936,470	7	328	68
Coal mines						
Total	3,639	238	6,929,380	9	344	51

[1] Compiled by the Bureau of Mines from reports by individual companies.
[2] Includes cement- and lime-processing plants.
[3] Includes only commercial operations.
[4] Preliminary figures.

TABLE 7.—Office of Minerals Exploration contracts active during 1963

County and contractor	Commodity	Contract		
		Date	Total amount	Government participation, percent
Boise: Congdon and Carey	Molybdenum	Mar. 4, 1963	$64,250	50
Custer: Clayton Silver Mines	Silver	Dec. 2, 1963	90,370	50
Lemhi: J. Howard Sims	Silver and gold	May 7, 1963	59,230	50

The Idaho Bureau of Mines and Geology published three general interest reports concerning mining and geology.[3]

[3] Ross, C. P. Geology Along U.S. Highway 93 in Idaho. Idaho Bureau of Mines and Geol. Pamphlet 130, July 1963, 98 pp.
Ross, C. P. Mining History of Southcentral Idaho. Idaho Bureau of Mines and Geol. Pamphlet 131, July 1963, 29 pp.
Wells, M. W. Gold Camps and Silver Cities. Idaho Bureau of Mines and Geol. Bull. 22, 1963, 86 pp.

TABLE 8.—Water use by the mineral industry in 1962
(Million gallons)

Industry	New water	Recirculated water	Total water requirements	Water discharged	Water consumed
Metal mines and mills	8,898	231	9,130	8,619	280
Nonmetal mines and mills	635	1,624	2,259	604	30
Sand and gravel mines and processing plants and quarry operations	501	----------	501	477	24
Total [1]	10,034	1,855	11,890	9,700	334

[1] Because of rounding, individual items may not add to totals shown.

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—Production of antimony contained in concentrate increased 14 tons over the 1962 output despite closure of the Sunshine mine by a strike by the United Steelworkers of America which began November 4 and was still in progress at yearend. Approximately 650 tons of cathode metal containing 95.1 percent antimony was recovered at the Sunshine Mining Co. electrolytic plant from ore mined at the Sunshine (92 percent) and Silver Summit (8 percent) mines, Shoshone County. Antimony Gold Ores Co., Boise, shipped 50 tons of concentrate containing about 62 percent antimony from the company 50-ton-per-day flotation mill near Yellow Pine. The ore was mined at various properties in Valley County.

Shipments of cathode metal by Sunshine Mining Co. totaled 501 tons, 173 tons less than in 1962. Cathode metal was sold mostly to secondary lead smelters for use in producing battery grid metal.

Beryllium.—Beryl occurrences were described in a report on the geology of the Sawtooth Range in central Idaho.[4]

Cadmium.—The Bunker Hill Co. recovered a record 1,057,728 pounds of cadmium as a byproduct of slab zinc production at the company electrolytic zinc plant. Cadmium recovery at the plant was improved by the installation of a new rectifier and by a change in the cathode-anode setup in the electrolytic cells.

Copper.—Production of copper was 4,172 tons, an increase of 8 percent over the 3,861 tons produced in 1962. Approximately 80 percent of the State output was from the Galena, Sunshine, and other Shoshone County mines. By far the greater quantity was recovered as a byproduct of silver ore. Largest production outside of Shoshone County was from the Blackbird No. 1 and No. 2 mines in Lemhi County and the Empire group in Custer County.

Gold.—Output of gold, the lowest on record (since 1884), declined to 5,477 ounces. Approximately 82 percent was recovered as a by-

[4] Reid, Rolland R. Reconnaissance Geology of the Sawtooth Range. Idaho Bureau of Mines and Geol. Pamphlet 129, July 1963, 37 pp.

product of base-metal and silver ores. Placer production declined to 144 ounces, the least since the record low of 1944 when 136 ounces was mined. Lode output was 156 ounces over the previous record low established in 1961.

Shoshone County mines yielded nearly 63 percent of the State total. As in 1961 and 1962, the Lucky Friday mine ranked first in output, followed by Gem State Consolidated Mines, Inc. (Dewey group), Gem County, and the Galena and Bunker Hill mines, Shoshone County.

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1954–58 (average)	98	26	1,955	12,245	$429	14,838	$13,429
1959	47	24	1,834	10,479	367	16,636	15,057
1960	79	20	1,105	6,135	215	13,647	12,351
1961	60	22	1,497	5,718	200	17,576	16,249
1962	60	13	1,586	5,845	205	17,772	19,283
1963	57	16	1,535	5,477	192	16,711	21,375
1863–1963 [3]			144,438	8,312,235	194,068	769,274	593,988

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	6,972	$4,528	64,605	$18,267	54,392	$12,709	$49,362
1959	8,713	5,350	62,395	14,351	55,699	12,811	47,935
1960	4,208	2,702	42,907	10,040	36,801	9,495	34,802
1961	4,328	2,597	71,476	14,724	58,295	13,408	47,178
1962	3,861	2,378	84,058	15,467	62,865	14,459	51,792
1963	4,172	2,570	75,759	16,364	63,267	14,551	55,052
1863–1963 [3]	183,247	78,430	7,171,859	994,489	2,400,930	496,199	2,357,174

[1] Includes recoverable metal content of gravel washed (placer operations). ore milled, old tailings, and old slag retreated, and ore shipped to smelters during the calendar year indicated. Because of rounding, individual items may not add to total shown.
[2] Does not include gravel washed.
[3] Partly estimated for years before 1901.

TABLE 10.—Gold production at placer mines

Year	Mechanical and hydraulic methods [1]			Small-scale hand methods			Total [2]		
	Number of operations	Material treated (thousand cubic yards)	Gold (troy ounces)	Number of operations	Material treated (thousand cubic yards)	Gold (troy ounces)	Number of operations	Material treated (thousand cubic yards)	Gold (troy ounces)
1954–58 (average)	16	495	3,676	10	4	67	26	499	3,743
1959	10	92	1,878	14	5	89	24	98	1,967
1960	9	64	793	11	6	50	20	70	843
1961	8	60	488	14	9	53	22	69	541
1962	7	38	318	6	8	58	13	46	376
1963	[3] 5	8	90	11	4	54	16	12	144

[1] Combined to avoid disclosing individual company confidential data.
[2] Data may not add to totals shown because of rounding.
[3] Includes 1 hydraulic operation, 2 dragline dredges, 1 suction dredge, and 1 nonfloating washing plant.

TABLE 11.—Mine production of gold, silver, copper, lead, and zinc in 1963, by counties, in terms of recoverable metals

County	Mines producing		Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
Benewah		1	2	[1]		
Boise	4	4	79	$3	1,734	$2
Boundary	2				989	1
Custer	6	1	365	13	126,409	162
Elmore	1		88	3	155	[1]
Gem	1		793	28	2,372	3
Idaho	6	5	101	4	483	1
Lemhi	9	2	371	13	7,820	10
Shoshone	16		3,427	120	16,523,143	21,135
Undistributed [2]	12	3	251	9	47,620	61
Total [3]	57	16	5,477	192	16,710,725	21,375

County	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
Benewah							[1]
Boise	2	$1	[4]	[1]	[4]	[1]	$6
Boundary	[4]	[1]	27	$6	1	[1]	7
Custer	248	153	686	148	90	21	496
Elmore							3
Gem	[4]	[1]	3	1	3	1	32
Idaho	[5]	[5]			[5]	[5]	4
Lemhi	543	334	147	32	21	5	394
Shoshone	3,332	2,053	74,794	16,156	63,118	14,517	53,980
Undistributed [2]	47	29	102	22	35	8	128
Total [3]	4,172	2,570	75,759	16,364	63,267	14,551	55,052

[1] Less than $500.
[2] Includes values and quantities that cannot be shown separately for Adams, Bear Lake, Blaine, Bonner, Camas, Gooding, Kootenai, Owyhee, and Valley counties.
[3] Individual items may not add to total shown.
[4] Less than 0.5 ton.
[5] Figure withheld to avoid disclosing individual company confidential data.

Placer production was from 16 operations in 8 counties of which Idaho County was the most significant, recording 86 ounces; 22 ounces was reported from Lemhi County, and Boise County had 16 ounces. The largest single output was by Idaho Mining & Milling Co. from the Florence Basin placers, Idaho County.

Iron Ore.—Production of iron ore increased to 5,812 long tons, 26 percent more than in 1962. The rise was attributable to production by C. C. Hill from the McCleary Butte property near Tensed, Benewah County. George Budock (Cudahy Mountain mine) and Joe Holcomb (Campbell and Mortimer mines) extracted ore at Washington County open-pit operations. Porter Bros. Corp. shipped a small quantity of magnetite sand from stockpiled material that had been mined previously at dredging operations in Valley County.

Lead.—A rise in metal price resulted in a 6-percent increase in the value of lead production despite an 8,300-ton drop (10 percent) in output from that of 1962. As a result of the decreased output combined with increased production in Missouri, Idaho dropped to second among lead-producing States; in 1962 Idaho was the largest lead-producing State for the first time since 1906.

TABLE 12.—Mine production of gold, silver, copper, lead, and zinc in 1963, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Ore:							
Dry gold	15	1,200	965	2,656	500	6,300	5,100
Dry gold-silver	3	10	25	559		100	100
Dry silver	12	348,456	944	10,254,978	5,340,000	3,002,000	619,200
Total	30	349,666	1,934	10,258,193	5,340,500	3,008,400	624,400
Copper	9	38,964	654	10,916	1,653,200	400	
Lead	10	183,337	1,776	3,479,569	614,700	38,434,100	3,254,700
Lead-zinc and zinc [2]	8	899,682	940	2,923,399	603,000	106,873,200	112,007,400
Total	27	1,121,983	3,370	6,413,884	2,870,900	145,307,700	115,262,100
Other lode material:							
Silver old tailings, lead-zinc mill cleanings, and antimony ore [2]	4	713	29	9,098	3,800	210,900	37,100
Zinc slag smelted	1	62,609		29,507	128,800	2,991,000	10,610,400
Total lode material	57	1,534,971	5,333	16,710,682	8,344,000	151,518,000	126,534,000
Placer	16	[3]	144	43			
Total, all sources	73	1,534,971	5,477	16,710,725	8,344,000	151,518,000	126,534,000

[1] Because some mines produce more than 1 class of material, detail will not necessarily add to total shown.
[2] Combined to avoid disclosing individual company confidential data.
[3] 11,970 cubic yards.

TABLE 13.—Mine production of gold, silver, copper, lead, and zinc in 1963, by types of material processed and methods of recovery, in terms of recoverable metals

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Amalgamation	495	374			
Concentration and smelting of concentrates	4,062	16,612,574	7,581,800	147,750,900	115,777,800
Total	4,557	16,612,948	7,581,800	147,750,900	115,777,800
Direct smelting:					
Gold	378	2,091	500	6,000	5,000
Silver	144	33,780	2,500	34,600	600
Gold-silver	25	559		100	100
Copper	176	3,590	624,400		
Lead	34	10,800	1,000	410,100	34,000
Lead-zinc and lead-zinc mill cleanings [1]	19	17,407	5,000	325,300	106,100
Old slag		29,507	128,800	2,991,000	10,610,400
Total	776	97,734	762,200	3,767,100	10,756,200
Placer	144	43			
Grand total	5,477	16,710,725	8,344,000	151,518,000	126,534,000

[1] Combined to avoid disclosing individual confidential data.

All except 965 tons of the 75,759-ton output came from mines in Shoshone County. The Bunker Hill Co. was by far the largest lead producer despite a drop in output from the Bunker Hill mine. Major production also was from the Lucky Friday mine, Star Unit area (Star and Morning mines), and Page mine. The largest producer outside Shoshone County was Clayton Silver Mines (Clayton mine), Custer County, which accounted for 680 tons.

Exploration and development of Idaho lead mines were at an accelerated pace, particularly in the Coeur d'Alene area. The Bunker Hill Co. continued driving a 3-mile-long crosscut from the 23 level of the Bunker Hill mine to connect with a 3100-level heading from the Crescent mine. At yearend the headings were less than 4,000 feet apart. The main shaft of the Lucky Friday mine was deepened to the 3250 level, and a 3050-level heading was begun to explore the adjoining Jutila property. Magna Mining Co. electrified the Princeton property in preparation for extensive exploration and development.

Production from The Bunker Hill Co. lead smelter was 93,426 tons. This below-capacity output was due to a shortage of lead concentrate.

Mercury.—The entire output, the first since 1961, was produced by Antimony Gold Ores Co. at the Hermes property near Yellow Pine, Valley County. Mercury was recovered from ore, mined by a stripping operation at the property, and from a cleanup of furnace material resulting from past operations. This was the first production from the mine since 1959.

Silver.—A decline in silver output to 16.7 million ounces compared with 17.8 million ounces in 1962 resulted mostly from the third labor strike in 3 years at the Sunshine mine in the Coeur d'Alene region of Shoshone County. However, despite the 6-percent production decrease, the value increased 11 percent over that of 1962 because of a higher average market price for the metal. Shoshone County mines supplied nearly 99 percent of the State total. Most of the output was from the three largest silver-producing mines in the Nation—Sunshine (Sunshine Mining Co.), Galena (American Smelting and Refining Co.), and Lucky Friday (Lucky Friday Silver-Lead Mines Co.). Other major producers included the Bunker Hill, Crescent, Silver Summit, Star Unit, and Page mines. The largest production outside Shoshone County was from the Clayton mine (Clayton Silver Mines) in Custer County.

The increased metal price kindled interest in developing new areas and maintained interest in exploration and development begun previously. Allied Silver, Inc., a Kellogg firm organized during the year, initiated a drilling project in the Coeur d'Alene mining region. Federal Resources Corp. began constructing a $500,000, 250-ton-per-day concentrator at the Silver Star-Queens property near Bellevue, Blaine County, and continued exploring and developing the Conjecture mine, Bonner County. Sunshine Mining Co. continued exploration drifting and diamond drilling at the Sunshine and adjoining properties. To facilitate deepening the Crescent winze, The Bunker Hill Co. temporarily discontinued driving a crosscut from the 3100 level of the Crescent mine toward the Bunker Hill mine. American Smelting and Refining Co. began deepening the main shaft at the Galena mine from the 4000 level to a new 4300 level.

Hecla Mining Co. began sinking a new winze to the 4000 level of the Silver Summit mine and announced plans for other exploration projects. Impending closure of the mine had been anticipated since 1961, but the new exploration was expected to disclose additional ore and prolong the life of the operation.

Two Office of Minerals Exploration loans were granted to explore for silver-bearing deposits. Contracts were awarded to J. Howard Sims for work in the Texas mining district, Lemhi County, and to

Clayton Silver Mines for drifting and drilling at the company property in Custer County.

Thorium.—Interest continued in developing thorium-bearing properties in the Lemhi Pass area, Lemhi County. A study of thorium deposits in the Lemhi Pass area of Idaho and Montana was published.[5]

Titanium.—Porter Bros. Corp. shipped ilmenite concentrate for use as roofing granules and as a component of drilling mud. The concentrate resulted from reprocessing stockpiled garnet-magnetite-ilmenite concentrate at the company Lowman mill, which was operated during part of the year. Garnet and magnetite concentrates also were recovered and marketed.

Titanium placer deposits in the State were described.[6]

Uranium.—There was no uranium output for the first time since 1956. Production had declined sharply each year since the record output of 1959.

Vanadium.—Production of vanadium declined sharply in 1963. Vanadium pentoxide was recovered from ferrophosphorus at three plants—Vanadium Corp. of America, Durango, Colo.; Kermac Nuclear Fuels Corp., Soda Springs; and Vitro Chemical Co., Salt Lake City, Utah. The Susquehanna Minerals plant at Garfield, Utah, remained closed during the year; ferrophosphorus from the FMC operation in Power County had been processed at the Garfield plant from November 1961 to May 1962.

Kermac Nuclear Fuels Corp., a subsidiary of Kerr-McGee Oil Industries, Inc., completed constructing a 750-ton-per-year vanadium pentoxide recovery plant near Soda Springs, Caribou County, to process byproduct ferrophosphorus from the nearby Monsanto Chemical Co. elemental-phosphorus operation.

Zinc.—Output of zinc was 63,267 tons, 402 tons more than was mined in 1962. All except 149 tons was from mines in Shoshone County. As in 1962, the Star Unit area (Star and Morning mines), operated by Hecla Mining Co., yielded the largest output, followed by the Bunker Hill and Page mines.

A record 81,296 tons of Special High Grade slab zinc was produced at The Bunker Hill Co. electrolytic zinc plant at Kellogg. Zinc concentrates were obtained from Idaho mines and other domestic and foreign properties.

NONMETALS

Barite.—Bannock Apex Mines produced a small tonnage of barite at an operation south of Pocatello in Power County. The J. R. Simplot Co. Sun Valley mine near Hailey in Blaine County remained idle; however, shipments from stockpiles were made to the company grinding plant near Pocatello. Shipments of ground barite, used as a weighting agent in oil-well-drilling muds, were more than double the 1962 rate.

Cement.—Portland and masonry cements were produced at the Inkom plant of Idaho Portland Cement Co. in Bannock County. Production and shipments of portland cement declined 9 percent,

[5] Sharp, W. N., and W. S. Cavender. Geology of Thorium-Bearing Deposits of the Lemhi Pass Area, Lemhi County, Idaho, and Beaverhead County, Mont. U.S. Geol. Survey Bull. 1126 (1962) 1963, 76 pp.

[6] Storch, R. H., and D. C. Holt. Titanium Placer Deposits of Idaho. BuMines Rept. of Inv. 6319 1963, 69 pp.

compared with totals for the previous year. Shipments of masonry cement also were lower. Cement movements were mainly to intrastate destinations; smaller quantities were shipped to other markets in the Rocky Mountain States.

Clays.—The quantity of clays sold or used by producers in Idaho increased sharply compared with the 1962 total. Increased output of miscellaneous clay, used for making heavy clay construction products, accounted for most of the rise. Shipments of paper (kaolin) and fire clays showed moderate increases over tonnages for the previous year.

Miscellaneous clay was dug from pits in Ada, Bonneville, Elmore, and Minidoka Counties, and fire clay for refractories manufacture was produced at one operation in Latah County. A small tonnage of bentonite for use as drilling mud and for sealing irrigation canals was shipped from an operation in Owyhee County. J. R. Simplot Co. continued producing paper-filler and refractory clay at the company Miclasil operation near Bovill, Latah County. At the Miclasil plant a raw material feed consisting of a mixture of clay, sand, and mica was separated and clay fractions were beneficiated to produce products suitable for use as paper and refractory clay.

Garnet.—Shipments of garnet by Idaho producers were 34 percent lower than in 1962. The quantity of crude material mined, however, increased compared with that of the previous year. Garnet was mined, concentrated, and shipped from two operations near Fernwood in Benewah County; Porter Bros. Corp. also shipped garnet from stockpiles near Lowman, Boise County.

Gypsum.—There was no mine production of crude gypsum; however, shipments of agricultural gypsum were made by Rock Island Gypsum Co. from stocks at the firm's Rock Creek mine near Weiser, Washington County. Quantities shipped were substantially greater than in 1962.

Lime.—Production of lime from limestone burned at sugar refineries in the State totaled 60,200 tons, compared with an output of 68,000 tons in 1962. Output was from lime kilns at sugar refineries in Bonneville, Canyon, Franklin, Minidoka, and Twin Falls Counties. Lime also was recovered from calcium carbonate sludge obtained from the chemicals recovery system at a Kraft paper plant in Nez Perce County. All production was for interplant use by the processing companies.

Mica.—Non-Metallics, Inc., Moscow, shipped a small quantity of scrap mica recovered from mine dumps and tailings at the Muscovite mine near Deary, Latah County. Output went to California markets. This was the first shipment of mica reported from the Muscovite mine since 1959 when a quantity of hand-cobbed ruby muscovite mica was shipped to the General Services Administration for stockpiling.

Peat.—A small quantity of reed-sedge peat was produced at one operation near Downey, Bannock County. Shipments were reduced sharply compared with those of 1962.

Perlite.—Oneida Perlite Corp. continued mining perlite at deposits north of Malad, Oneida County. The quantity of crude ore mined was reduced sharply compared with output for 1962. The firm shipped crude perlite to expanding plants in the Western United States and Canada and processed crude perlite at the company expanding

plant at Malad. The expanded product was marketed mainly for use as concrete aggregate and as loose-fill insulation; other markets included use as lightweight-plaster aggregate and for soil conditioning. Expanded perlite production at the Malad plant was greater than in 1962.

Phosphate Rock.—Production of marketable phosphate rock by Idaho producers totaled 1.7 million long tons, a decline of 11 percent from the 1.9 million long tons produced in 1962. The quantity of crude phosphate rock ore mined also was lower than in 1962. Mine production was from three operations in two counties. The Central Farmers Fertilizer Co. Georgetown Canyon mine in Bear Lake County was idle throughout the year. Phosphate rock for the firm's Georgetown fertilizer works and elemental phosphorus plant was obtained from stockpiles.

Phosphate rock sold or used by producers—1.7 million long tons—remained substantially the same as in 1962. Elemental phosphorus manufacture continued as a leading use of phosphate rock mined in the State. The quantity of rock used for this purpose increased slightly. Other uses were for manufacturing wet-process phosphoric acid and phosphate fertilizers.

Phosphate rock was reduced to elemental phosphorus at plants of FMC Corp., Pocatello; Monsanto Chemical Co., Soda Springs; and Central Farmers Fertilizer Co., Georgetown. Phosphorus production by FMC Corp. and Monsanto Chemical Co. went mainly for manufacturing various phosphorus derivatives used for industrial applications. Phosphorus produced by the Central Farmers firm was used for manufacturing phosphate fertilizers at the company Georgetown plant.

In October, Central Farmers Fertilizer Co. announced closure of its electric-furnace elemental phosphorus plant and phosphoric acid plant at Georgetown. The firm, since 1959, had produced elemental phosphorus which was converted to phosphoric acid for use in manufacturing high-analysis phosphate fertilizers. Fertilizer production and shipments at the Georgetown plant were continued throughout the year.

J. R. Simplot Co. continued manufacturing ammonium phosphate and triple superphosphate fertilizers and wet-process phosphoric acid at its fertilizer complex west of Pocatello in Power County. In April, the company announced a $10 million expansion program which was to double fertilizer-production capacity at Pocatello. Included in the initial phases of the expansion were erection of a 700-ton-per-day sulfuric acid plant and construction of a 150-ton-per-day ammonia-from-natural-gas plant. Both facilities were operating at year end. Work also was started on a second Fluosolids calciner at the Pocatello site. Also to be expanded were production capacities for phosphate fertilizers, phosphoric acid, and ammonium phosphate fertilizers. Production of high-analysis phosphoric acid containing 68 to 72 percent P_2O_5 compared with the conventional, or merchant-grade, acid containing 52 to 54 percent P_2O_5 was scheduled to increase. The company Conda mining and beneficiating operation in Caribou County also was to be enlarged to provide additional ore for the Pocatello fertilizer operation. Included in the Conda program was additional grinding, beneficiating, and ore handling equipment. The

overall expansion program was scheduled to be completed over a 3-year period.

The Bunker Hill Co., Kellogg, Shoshone County, continued producing fertilizer-grade phosphoric acid from sulfuric acid obtained from a nearby company-owned acid plant and from phosphate rock purchased from producers in Wyoming. The plant was operated intermittently because of seasonal demand for the fertilizer-grade product.

International Minerals & Chemical Corp. exploration crews continued investigating phosphate properties leased by Husky Oil Co. north of Soda Springs, Caribou County.

Pumice and Volcanic Cinder.—The quantity of pumice and volcanic cinder sold or used by producers was more than double the total of 1962. Pumice produced for road base and surfacing use at State highway department projects in Bingham County was the principal reason for the sharp increase. Output by commercial firms was 8 percent greater than in 1962. Production was reported from six operations in five counties. Bingham County operations yielded the largest tonnage owing to production contracted for road use by the State highway department. Bonneville County ranked second as a producing area; output also was reported from operations in Canyon, Oneida, and Twin Falls Counties.

Commercial production of pumice and volcanic cinder was used mainly as lightweight aggregate in concrete building products; smaller quantitites were used as surfacing material and as insulation. The Idaho Bureau of Mines and Geology conducted a survey of volcanic materials in the State to determine possible use of these materials by the construction industry. Deposits were examined, and laboratory tests of certain volcanic materials were made.

Sand and Gravel.—Sand and gravel produced for all purposes totaled 12.4 million tons, a decline of 13 percent from the 14.3 million tons produced in 1962. Decreased demand for sand and gravel at State highway department projects (7.1 million tons compared with 8.8 million tons in 1962) was the principal reason for the decline; curtailed requirements for these commodities by the Bureau of Public Roads and the U.S. Forest Service also contributed.

Production by commercial firms was 1.7 million tons compared with 2.7 million tons in 1962. Government-and-contractor tonnage (largely contractor production for Federal, State, county, and municipal agencies) was 10.7 million tons, a decline of 8 percent from the 11.6 million tons reported in 1962. Production was reported from operations in 39 of the 44 counties in the State. Bonneville County was the principal producing area; Ada and Bannock Counties ranked second and third, respectively.

Universal Lumber and Supply Co. (Del Monte Properties Co.) continued production of quality sand for plaster, glass, foundry, and abrasive use from an operation unit near Emmett, Gem County.

Stone.—Stone quarried for all purposes totaled 1.2 million tons—a decline of 15 percent from the 1.4 million tons produced in 1962. Curtailed requirement for crushed stone by the State highway department was the principal reason for the smaller tonnage. Commercial firms produced 895,000 tons, and Government-and-contractor output (largely by contractors for Federal, State, county, and municipal

TABLE 14.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	772	$1,180	397	$616
Road material	1,757	1,440	1,167	1,228
Fill	70	45	24	25
Other [1]	88	92	135	320
Total	2,686	2,756	1,724	2,189
Government-and-contractor operations:				
Building	25	24	----	----
Road material	11,340	10,138	9,784	7,902
Fill	269	111	925	524
Total	11,634	10,273	10,709	8,426
All operations:				
Building	797	1,203	397	616
Road material	13,097	11,578	10,951	9,130
Fill	339	155	950	549
Other [1]	88	92	135	320
Total [2]	14,321	13,029	12,433	10,615

[1] Includes special sands, railroad ballast, and sand and gravel used for miscellaneous purposes.
[2] Owing to rounding, individual items may not add to totals shown.

agencies) was 273,000 tons, compared with 797,000 tons and 584,000 tons, respectively, in 1962. In terms of tonnage, basalt continued to be the principal stone quarried, and production was used mainly as road base and surfacing material.

The quantiy of limestone quarried, 24 percent less than in 1962, was largely used in manufacturing cement; smaller quantities were used at metallurgical smelters and sugar refinieries and as agricultural limestone. Quartzite, used as a flux in elemental phosphorus furnaces, was quarried in Caribou County. Stone production was reported from operations in 17 of the 44 counties in the State.

MINERAL FUELS

Petroleum and Natural Gas.—A new agency, the Idaho Oil and Gas Conservation Commission, was created by the 1963 State Legislature. Personnel of the Board of Control of the Idaho Bureau of Mines and Geology were designated as members of the agency.

Three drilling permits were issued by the State agency during the year.

REVIEW BY COUNTIES

Mineral production was recorded from 42 of the 44 counties. Shoshone County accounted for 66 percent of the total mineral-output value. Sand and gravel and stone were the principal or only products from 27 counties. Selected counties with significant metal and nonmetal developments are discussed in the following review.

Adams.—Copper ore was mined by Otto Russell from the Old Peacock mine in the Seven Devils mining district. Production from the open-pit operation was below the 1962 total.

Bannock.—Production of portland and masonry cements at the Idaho Portland Cement Co. Inkom plant continued as the principal mineral industry activity in the county. Limestone, the principal raw material used at the plant, was obtained from the nearby Inkom quarry; iron ore, gypsum, and silica, the other raw materials used in quantity, were purchased. Idaho Peat, Inc., shipped a quantity of reed-sedge peat from an operation near Downey. Sand and gravel production increased sharply, owing to greater use of these commodities at State highway department projects in the county.

Bear Lake.—Three tons of lead was recovered from 5 tons of ore extracted from the Sunset mine in the St. Charles district by Roy Polhamus.

TABLE 15.—Value of mineral production in Idaho, by counties [1]

(Thousand dollars)

County	1962	1963	Minerals produced in 1963 in order of value
Ada	$762	$1,718	Sand and gravel, clays.
Adams	86	(1)	Copper, silver, gold.
Bannock	(1)	(1)	Cement, sand and gravel, stone, peat.
Bear Lake	(1)	(1)	Phosphate rock, sand and gravel, lead.
Benewah	165	176	Abrasive garnet, sand and gravel, iron ore, gold.
Bingham	(1)	(1)	Phosphate rock, pumice, sand and gravel, vanadium, stone.
Blaine	208	(1)	Silver, lead, barite, zinc, gold, copper.
Boise	6	29	Sand and gravel, gold, silver, copper, lead, zinc.
Bonner	400	432	Stone, sand and gravel, silver, gold, lead.
Bonneville	[4] 3,093	1,948	Sand and gravel, lime, pumice, clays, stone.
Boundary	264	50	Sand and gravel, lead, silver, stone, zinc, copper.
Butte	68		
Camas		(2)	Gold, silver, lead, zinc.
Canyon	704	943	Sand and gravel, lime, pumice.
Caribou	(1)	(1)	Phosphate rock, stone, sand and gravel, vanadium.
Cassia	133	548	Sand and gravel.
Clark	5	19	Sand and gravel, stone.
Clearwater	330	95	Stone, sand and gravel.
Custer	459	496	Silver, copper, lead, zinc, gold.
Elmore	119	96	Sand and gravel, gold, clays, silver.
Franklin	94	21	Sand and gravel, lime.
Fremont	621	6	Sand and gravel, stone.
Gem	221	335	Sand and gravel, gold, silver, lead, zinc, copper.
Gooding	43	71	Sand and gravel, gold, silver.
Idaho	571	552	Sand and gravel, stone, gold, silver, copper, zinc.
Jefferson	660	160	Sand and gravel.
Jerome	51		
Kootenai	753	207	Sand and gravel, stone, silver.
Latah	364	399	Clays, stone, sand and gravel, mica.
Lemhi	376	660	Copper, sand and gravel, lead, gold, silver, zinc.
Lewis	(1)	(1)	Stone.
Lincoln	33	66	Sand and gravel.
Madison	406	367	Sand and gravel, stone.
Minidoka	374	191	Lime, sand and gravel, clays, stone.
Nez Perce	410	354	Sand and gravel.
Oneida	258	336	Sand and gravel, pumice, perlite, stone.
Owyhee	124	11	Sand and gravel, gold, silver, lead, zinc, clays.
Payette	17	12	Sand and gravel.
Power	278	417	Sand and gravel, barite.
Shoshone	51,386	54,466	Silver, lead, zinc, copper, antimony, stone, gold, sand and gravel.
Teton		17	Sand and gravel.
Twin Falls	731	656	Sand and gravel, lime, pumice.
Valley	81	126	Sand and gravel. ilmenite, antimony, iron ore, mercury, abrasive garnet, gold, silver.
Washington	(1)	(1)	Sand and gravel, iron ore.
Undistributed [3]	17,960	16,775	
Total	[4] 82,614	82,755	

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Less than $500.
[3] Includes value of mineral production that cannot be assigned to specific counties and values indicated by footnote 1.
[4] Revised figure.

There was no mine production of crude phosphate rock ore because the Georgetown Canyon mine of Central Farmers Fertilizer Co. was not operated during the year. Stockpiles of phosphate rock were used as a source of raw material for the company fertilizer and elemental phosphorus plants at Georgetown. In October the firm's 35,000-kilovolt-ampere phosphorus furnace and phosphoric-acid-from-phosphorus plant at the Georgetown fertilizer complex were shut down, resulting in the layoff of approximately 200 employees. Production and shipments of phosphate fertilizer, however, were continued throughout the year.

Benewah.—C. C. Hill shipped 3,208 long tons of iron ore (hematite) from the McCleary Butte property near Tensed to an Ideal Cement Co. plant.

Abrasive garnet was produced and shipped from two operations near Fernwood. Emerald Creek Garnet Milling Co. constructed a new beneficiating mill and bagging unit to replace facilities that were destroyed by fire in May 1962. Sand and gravel production was contracted by the Bureau of Public Roads for roadbuilding projects in the county.

Bingham.—J. R. Simplot Co. continued mining phosphate rock and phosphatic shale at the Gay mine near Fort Hall. Mine production was lower than in 1962 because of a labor dispute which idled the operation from December 1962 until April. Sand and gravel output was reduced sharply owing to curtailed requirements by the State highway department. Basalt was quarried for use as riprap at State and Federal projects in the county.

Blaine.—Federal Resources Corp. began constructing a 250-ton-per-day mill and related facilities to process ore from the Silver Star-Queens mine. Exploration and development at the mine consisted of 1,929 feet of raising, 3,422 feet of drifting and crosscutting, 408 feet of diamond drilling, and 1,677 feet of long-hole drilling. No ore was shipped to a smelter during the year, but 5,975 tons of development ore was stockpiled pending completion of the new concentrator, scheduled for early in 1964. In addition, approximately 60,000 tons of ore was developed on the 450 level of the mine.

Idaho-Pacific Mining Co. processed material from three Warm Springs district mines—Homestake, Independence, and Ontario—in its mill near Ketchum. The Silver Spar mine (Silver Spar Mining Co.), Little Wood River district, yielded a small quantity of silver ore.

Boise.—Four lode mines were operated; gold and copper ore was shipped from the Hayfork mine (Boise Basin district) and gold and silver ore came from the Come Back mine (Boise Basin district), Jessies claim group (Summit Flat district), and Bonanza claims (unorganized district). A small quantity of gold was recovered at four placer operations.

A $64,250 Office of Minerals Exploration loan was granted to Messrs. Congdon and Carey to explore for molybdenum ore bodies.

Bonner.—Federal Resources Corp. continued exploration and development of the Conjecture mine near Bayview in the Lakeview district. Work consisted of 171 feet of raising, 2,079 feet of drifting and crosscutting, 6,840 feet of diamond drilling, and 900 feet of long-hole drilling. Phelps Dodge Corp. conducted a diamond-drilling

and geophysical program at the Big Step prospect south of Priest Lake; however, late in the year the company terminated its option to buy the 1,200-acre property. The Talache mine near Sandpoint was the scene of exploration drifting. Silver ore was extracted from the Weber mine, Lakeview district, by Austin-Meyer Corp.

Bonneville.—Production of 2.9 million tons of sand and gravel (3.0 million tons in 1962) ranked the county as the principal sand-and-gravel-producing area in the State. Output was mainly for use at State and county road projects. Pumice was produced at operations near Idaho Falls by Idaho Concrete Products, Inc., and Idaho Falls Pumice, Inc. The quantity mined increased moderately compared with that for 1962. Limestone was processed to quicklime by the Utah-Idaho Sugar Co. at Idaho Falls for on-site use in the sugar refining process. Clay for use in making heavy clay construction products was mined near Idaho Falls.

Boundary.—Idaho Continental Mines, Inc., an Idaho corporation formed during the year, produced lead ore from the Idaho Continental mine in the Port Hill mining district. A & P Mining Co. concentrated tailings from the Old Dam claims in a portable flotation mill capable of being mounted on a 40-foot semitrailer. Two hundred tons of tailings was reduced to 4 tons of concentrate containing 67 ounces of silver and 3,200 pounds of lead.

Caribou.—The new Kermac Nuclear Fuels vanadium pentoxide recovery plant at Soda Springs, built by Western-Knapp Engineering Co., was expected to eventually employ 30 to 35 people.

Phosphate rock production continued from the Ballard properties of Monsanto Chemical Co. and from the Conda operation of J. R. Simplot Co. Production at both operations was greater than in 1962. The Conda mine production was beneficiated and shipped by rail to the Simplot Company fertilizer works at Pocatello. The Ballard mine production was transported by truck over a private-haulage road to the Monsanto company elemental phosphorus plant at Soda Springs. Quartzite quarried near Soda Springs was used as a flux at the nearby Monsanto elemental phosphorus plant. Increased demand for sand and gravel at Bureau of Public Roads projects in the county caused a sharp rise in output of these commodities, compared with totals for 1962.

Custer.—Clayton Silver Mines (Clayton mine) again was the major producer in the county. Approximately 21,600 tons of ore from the 500 and 800 levels of the mine was milled and 23 ounces of gold, 119,-105 ounces of silver, 14 tons of copper, 680 tons of lead, and 89 tons of zinc were recovered. Net smelter returns were $245,056, and $21,839 was received under the Government lead and zinc mining stablization program. Stablization payments were terminated on July 31 since, under the amended Small Mines Stablization Act, Clayton failed to qualify as a small domestic lead producer because its 1962 income from silver and copper exceeded the income from lead. In December, a $90,916 Office of Minerals Exploration loan was approved for drifting and diamond drilling in search of downward extensions of the North ore body.

R. V. Lloyd & Co. produced sizable quantities of copper ore from the Empire group in the Alder Creek district. Approximately 12 men were employed at the mining and milling operation. In the

same district the White Knob Mining Co. extracted lead ore from the White Knob mine. Operations at three mines—Bachelor Mountain, Charles Dickens, and Copper Lode & Mountain King—in the Yankee Fork district recorded production.

Salmon River Scheelite Corp. reported that over 100,000 tons of milling-grade ore had been blocked out in the company mine near Salmon.

Elmore.—Talache Mines, Inc., mined 350 tons of gold ore from the Boise-Rochester mine, Middle Boise district.

Gem.—Gem State Consolidated Mines, Inc. (Dewey group), operating the only metal-producing mine in the county, mined 654 tons of gold ore that yielded 793 ounces of gold, 2,372 ounces of silver, 3 tons of lead, and 2.5 tons of zinc.

Idaho.—Small quantities of gold- and silver-bearing ore were shipped from six lode mines in six different mining districts. Five placer operations produced 60 percent (86 ounces) of the State placer gold output. The largest producer, Idaho Mining & Milling Co. (Florence Basin placers), announced plans to end placer mining activities.

Latah.—Fire clay was mined north of Helmer for use at the Troy refractory-products plant of A. P. Green Firebrick Co. J. R. Simplot Co. continued operating the Miclasil clay-sand separation plant at Bovill, producing clay suitable for use as paper-filler material and for refractories. Non-Metallics, Inc., began constructing a mica-grinding mill at the Muscovite mine north of Deary. Mine dumps and tailings from previous mica-trimming operations were worked during the year to recover a quantity of scrap mica. Sand and gravel and crushed stone (basalt) were produced for use at State highway department and other road projects in the county.

Lemhi.—Value of base- and precious-metal production from county mines ranked third in the State behind that of Shoshone and Custer Counties. The sharp rise in output over that of 1962 resulted from copper ore production at the Blackbird No. 1 (Earl Waite and William Barnes) and Blackbird No. 2 (Machinery Center, Inc.) mines in the Blackbird mining district. Both ore and concentrate were shipped to copper smelters at Anaconda, Mont., and Tacoma, Wash.

Copper ore was shipped from the Salmon Canyon (Gold Hill district), Lucky Cuss (Indian Creek district), and Copper Queen (McDevitt district) mines. Sizable quantities of lead and zinc ore were mined at the Nicholia (Spring Mountain district) and United Idaho (Texas district) properties.

A $59,230 Office of Minerals Exploration loan was granted to J. Howard Sims for geochemical sampling, trenching, and underground exploration in search of gold and silver ore bodies in the Texas mining district. Government participation was to be $29,615.

Oneida.—Oneida Perlite Corp. continued mining perlite from deposits north of Malad; however, the quantity mined was reduced sharply compared with the 1962 total. The crude ore was crushed and screened at facilities near the mine, and the sized material was trucked to the company storage and expanding plant at Malad. Pumicite was mined at the Wright's Creek deposit near Malad by South Idaho Construction Co., Inc. Contractors produced road gravel for use at State highway department projects in the county.

Power.—Vitro Chemical Co. modified its Salt Lake City, Utah, uranium plant to produce vanadium pentoxide and began processing vanadium-bearing ferrophosphorus from the FMC Corp. elemental-phosphorus-producing operation. FMC ferrophosphorus had been shipped to Susquehanna Minerals, Garfield, Utah, in 1961 and 1962.

A small quantity of barite was mined by Bannock Apex Mines at a surface operation approximately 36 miles south of Pocatello. The crude ore was shipped to Salt Lake City, Utah, for grinding. Sand and gravel for road construction purposes also was produced. Output increased substantially compared with totals for 1962, owing to greater demand for these materials at State highway department projects in the county. Phosphate rock mined in Bingham and Caribou Counties was processed at two plants. FMC Corp. continued production of elemental phosphorus at its electric-furnace plant west of Pocatello. Phosphate rock mined at the Gay mine in Bingham County was utilized at the plant. J. R. Simplot Co. produced phosphate fertilizers at the company manufacturing complex west of Pocatello. Company-operated mines in Bingham and Caribou Counties furnished the phosphate rock requirements. Barite shipped from stockpiles at the firm's Sun Valley mine in Blaine County was ground at the Simplot operation at Pocatello.

Sulfur obtained from recovery plants in Montana and Wyoming was converted to sulfuric acid by J. R. Simplot Co. for use at the firm's fertilizer complex near Pocatello. A second acid plant, a 700-ton-per-day unit, was placed in operation. The new plant augmented production from a 400-ton-per-day plant that had been placed in operation in 1959.

Shoshone.—The county accounted for 98 percent of the value of base- and precious-metal output in the State. Sixteen mines supplied 99 percent of the silver, lead, and zinc, 63 percent of the gold, and 80 percent of the copper produced in the State. Total value of base- and precious-metal output increased nearly $3 million, largely owing to higher market prices.

The Bunker Hill Co. lead smelter at Kellogg was closed for 2 weeks in August because of inadequate concentrates to maintain capacity operation throughout the year. The company electrolytic plant was operated at capacity throughout the year. Bunker Hill announced that the lead smelter had been operated for 46 years, during which 2.9 million tons of lead, over 333 million ounces of silver, 3.3 million pounds of cadmium, 554,000 ounces of gold, and 39,000 tons of copper were recovered. During 35 years of operation at the company zinc plant, 1,346,814 tons of slab zinc, 13,654,000 pounds of cadmium, and 703,612 tons of sulfuric acid were produced.

Allied Silver, Inc., a Kellogg firm organized during the year to explore a tract of 400 mining claims in the Coeur d'Alene mining region near the Sunshine property, began drilling to test promising structures and formations at depth. Companies involved in the new firm included Sunshine Mining Co., Silver Bowl, Inc., Coeur d'Alene Silver Giant, and Silver Pirate, Inc., all of Kellogg. Seven other firms held stock interest in the venture.

TABLE 16.—Production of gold, silver, copper, lead, and zinc in the Coeur d'Alene region, Shoshone County, Idaho, in terms of recoverable metals 1884–1963 [1]

Year	Material treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)	Total value
1884	(2)	12,500					$258,375
1885	(2)	18,220					376,607
1886	(2)	8,823	116,246		1,500		436,335
1887	(2)	7,367	340,000		5,980		1,022,996
1888	(2)	10,250	554,000		8,000		1,438,227
1889	(2)	8,433	1,095,265		17,500		2,532,978
1890	(2)	8,000	1,499,663		27,500		4,132,506
1891	(2)	10,000	1,825,765		33,000		4,868,356
1892	(2)	11,000	1,195,904		27,839		3,538,684
1893	(2)	14,748	1,963,561		29,563		4,258,621
1894	(2)	17,531	2,343,314		30,000		3,816,026
1895	(2)	18,439	2,471,300		31,000		4,016,049
1896	(2)	17,369	3,163,657		37,250		4,703,971
1897	(2)	16,404	3,756,212		57,777		6,764,010
1898	(2)	13,011	3,521,982		56,339		6,565,287
1899	(2)	8,602	2,737,218		50,006		6,263,404
1900	(2)	5,754	5,261,417		81,535		10,588,707
1901	(2)	4,915	4,339,296		68,953		8,731,662
1902	(2)	4,761	5,033,928		74,739		8,847,552
1903	(2)	7,651	5,471,620		103,691		11,885,078
1904	1,410,245	2,226	6,143,001	712	112,584		13,592,014
1905	1,526,927	1,886	7,292,986	2,613	126,928	72	17,198,856
1906	1,622,975	4,190	7,944,338	3,197	126,011	1,027	21,133,963
1907	1,541,670	3,952	7,266,862	3,600	114,721	3,474	18,888,203
1908	1,551,680	3,878	6,364,552	4,521	102,069		13,220,853
1909	1,569,332	4,326	6,201,157	4,453	106,779	640	13,724,065
1910	1,639,781	3,148	6,703,080	3,009	109,879	2,763	14,416,910
1911	2,004,487	4,162	7,383,899	1,463	127,419	4,155	16,306,680
1912	2,108,037	4,084	7,558,314	2,193	132,276	6,900	18,313,604
1913	2,289,226	3,955	9,337,109	2,549	148,370	10,708	20,767,410
1914	2,152,268	3,104	12,178,194	2,121	169,849	20,762	22,728,903
1915	2,255,475	2,246	11,158,955	971	164,199	34,843	30,119,424
1916	2,516,325	2,247	11,639,841	1,185	178,117	43,119	44,424,716
1917	2,522,127	4,145	11,241,126	1,438	186,004	38,862	50,054,297
1918	1,918,052	11,874	8,447,219	1,353	139,307	21,831	33,115,903
1919	1,308,063	8,687	4,815,200	737	83,833	7,997	15,900,815
1920	1,822,488	5,897	6,386,663	286	118,105	13,966	28,347,791
1921	1,379,178	8,306	4,986,263	202	94,543	17	13,720,730
1922	1,249,536	7,056	4,690,097	171	91,216	2,033	15,147,542
1923	1,535,011	13,182	6,117,621	300	114,426	13,976	23,297,547
1924	1,596,280	8,602	6,695,830	328	118,327	7,654	24,677,235
1925	1,714,159	6,615	6,701,747	310	120,856	15,578	28,272,585
1926	1,850,519	3,441	6,952,074	481	128,834	26,267	29,097,421
1927	1,919,309	416	8,256,126	653	141,948	26,131	26,091,273
1928	1,949,980	428	8,513,048	522	139,276	28,665	24,792,445
1929	1,971,580	511	8,776,726	660	141,558	43,046	28,439,351
1930	1,794,929	563	8,831,461	785	129,311	33,145	19,728,887
1931	1,239,592	456	7,003,541	522	97,771	18,934	10,809,561
1932	912,664	394	6,547,674	565	71,505	10,251	6,831,168
1933	1,052,889	1,584	6,762,537	772	73,926	20,958	9,737,204
1934	1,071,059	3,965	7,062,640	736	70,331	24,799	12,159,340
1935	1,237,244	2,714	9,892,910	987	78,290	31,009	16,361,388
1936	1,454,987	2,454	13,740,222	1,315	86,634	44,310	23,370,963
1937	1,731,801	3,659	18,457,726	1,944	96,505	47,070	32,382,311
1938	1,514,278	4,053	17,325,379	1,883	82,274	31,937	22,346,313
1939	1,611,068	5,928	15,204,934	2,068	81,699	40,065	22,805,024
1940	1,917,235	6,886	15,616,852	2,680	95,609	62,948	29,444,265
1941	2,051,390	3,419	14,678,356	2,979	95,529	68,321	32,398,932
1942	2,327,417	2,688	12,977,287	2,993	106,474	78,313	38,880,253
1943	2,270,385	2,250	10,302,840	1,987	89,813	79,634	38,594,728
1944	2,765,483	2,075	8,669,371	1,289	76,813	85,227	38,307,297
1945	2,794,208	1,898	7,115,646	1,018	63,430	78,030	34,258,050
1946	2,559,636	1,758	5,655,672	810	56,548	67,429	33,673,731
1947	2,957,143	2,808	9,234,906	1,312	73,060	79,251	49,226,932
1948	3,165,780	3,362	10,598,338	1,388	82,587	83,801	62,168,955

See footnotes at end of table.

TABLE 16.—Production of gold, silver, copper, lead, and zinc in the Coeur d'Alene region, Shoshone County, Idaho, in terms of recoverable metals 1884–1963 [1]—Continued

Year	Material treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)	Total value
1949	2,282,614	2,438	9,146,146	1,171	74,152	74,370	$50,699,924
1950	2,542,169	3,416	15,056,131	1,896	94,697	86,103	64,555,947
1951	2,393,939	2,684	13,639,808	1,874	70,570	74,989	65,058,887
1952	2,327,536	2,476	13,752,081	1,862	67,330	70,316	58,459,368
1953	1,788,426	2,376	13,636,680	2,100	69,885	68,650	47,729,814
1954	1,630,250	2,047	14,898,699	2,566	64,812	58,736	45,515,124
1955	1,637,121	1,777	12,984,323	2,637	59,820	50,527	44,036,867
1956	1,674,781	1,963	12,663,214	2,889	60,221	46,738	45,700,809
1957	1,710,442	2,254	14,397,771	3,473	67,125	54,825	47,117,496
1958	1,336,544	2,363	15,615,220	3,884	52,488	49,532	38,644,972
1959	1,421,957	2,349	16,460,825	3,678	61,155	55,454	44,058,455
1960	979,857	2,591	13,458,522	2,606	41,692	36,639	33,153,169
1961	1,434,379	3,279	17,369,240	3,673	70,651	58,184	46,312,680
1962	1,537,301	[3] 3,962	17,578,155	3,435	83,339	62,713	[3] 51,085,455
1963	1,462,873	3,427	16,523,143	3,332	74,794	63,118	53,980,184
Total	109,514,087	438,658	669,300,626	109,140	6,700,445	2,270,812	1,970,430,420

[1] Because of rounding, individual items may not add to totals shown.
[2] Not available.
[3] Revised.

The Coeur d'Alene mining region in 1963 was the subject of a report,[7] and a geological description of a quadrangle in the southwest corner of the Coeur d'Alene mining region was published.[8]

Beaver District.—Kennedy and Zanetti continued to operate the Mountain Goat and Interstate mines, leased since 1955 from Day Mines, Inc., at about the 1962 rate. Most of the metal was recovered from fill material pulled from abandoned stopes in the Interstate mine. Former operators had placed the low-grade material in mined-out stopes to help stabilize the area. The lessees continued to receive payments for production under the Federal Small Mines Aid Bill (Public Law 87–347). The mining and milling operation was described.[9]

Eagle District—A small amount of copper ore was mined by Rock City Mining Co., the only active operation in the district.

Evolution District—The Sunshine mine continued as the largest silver-producing mine in the Nation despite the loss of nearly 2 months' production because of a labor strike. Gold (179 ounces), silver (4,973,156 ounces), copper (870 tons), lead (695 tons), and zinc (196 tons) were recovered from 132,637 tons of ore mined. Average operating cost per ton of ore mined was $33.54, according to the annual report to shareholders. As a result of extensive exploration and

[7] Idaho Bureau of Mines and Geology. The Coeur d'Alene Mining District in 1963. Pamphlet 133, 1963, 104 pp.
[8] Campbell, Arthur B., and Stanley E. Good. Geology and Mineral Deposits of the Twin Crags Quadrangle, Idaho. U.S. Geol. Survey Bull. 1142-A, 1963, 33 pp.
[9] Rice, Robert A. Hard Work and Persistence Pay Off for Idaho's Mountain Goat Leasers. Min. World, V. 25 No. 11, November 1963, pp. 16–27.

development—10,717 feet of drifting, raising, sinking, and crosscutting, and 13,656 feet (121 holes) of diamond drilling—ore reserves (as of December 31) were increased to 457,750 tons, an increase of approximately 100,000 tons over the previous yearend total and the largest reserve since January 1, 1957. The mine's No. 10 shaft was sunk to a point 125.5 feet below the 4600 level, and extensive development was conducted on the 4200 and 4400 levels along the Chester vein in the eastern portion of the mine. Diamond drilling of the Syndicate fault in the Big Creek Apex area on the 4000 level disclosed a mineralized section of the fault.

Improved mining methods used at the Sunshine mine were described.[10]

The Hecla Mining Co. annual report to shareholders reported mining 20,006 tons of ore, assaying 24 ounces of silver per ton and 0.6 percent copper, from the Silver Summit mine. The ore was concentrated at the Polaris mill. The concentrate was processed at the Sunshine electrolytic antimony plant until the strike at the Sunshine operation; thereafter, the concentrate was shipped directly to the Tooele (Utah) smelter. The increased silver price spurred development of deeper levels of the mine. Sinking a winze shaft an additional 600 feet was begun, and plans were made to achieve production from the 3600, 3800, and 4000 levels. Sinking the winze was expected to develop about 20,000 tons of ore previously indicated by drilling from the 3400 level. Ore reserves at yearend were estimated to be 24,000 tons, compared with 6,800 tons at the end of the 1962. Rock drilling at the mine was the subject of a report.[11]

Hunter District—According to the Hecla Mining Co. annual report to shareholders, the company operated the Lucky Friday mine without interruption and milled 182,337 tons of ore assaying 19.5 ounces of silver per ton, 10.7 percent lead, and 1.1 percent zinc. Directors of Lucky Friday Silver-Lead Mines Co. and Hecla Mining Co. approved an agreement to merge the two companies. The agreement was to be submitted to stockholders for ratification in 1964.

Production from the Star Unit area (operated by Hecla Mining Co.) was 253,513 tons of ore containing 484,656 ounces of silver, 11,930 tons of lead, and 25,345 tons of zinc, according to The Bunker Hill Co. annual report. Yearend ore reserves were 829,366 tons, the largest since 1959. The reserve increase was due to deeper development of the Star-Morning and Noonday veins. Sinking the Star winze to the 7100 level to tap ore exposed on the 6900 level was planned for 1964. The Morning mine (American Smelting and Refining Co.) was operated through the Star mine as part of the Star Unit area.

Lelande District—W. Fannan and L. Bailey produced lead ore from the Sherman mine. The mine was leased from Day Mines, Inc.

[10] Mining World. Improved Methods at Sunshine Mine Sends Higher Grade Silver Ore to Mill. V. 25, No. 2, February 1963, pp. 14–17.
Schulze, Henry W. Lateral Driving at the Sunshine Mine. Min. Cong. J., V. 49, No. 12, December 1963, pp. 34–37.

[11] Banister, D'Arcy and W. R. Wellman. Methods and Costs of Rock Drilling at the Silver Summit Mine, Hecla Mining Co., Shoshone County, Idaho. BuMines Inf. Circ. 8159, 1963, 19 pp.

Placer Center District—The only production in the district was from the Galena mine. Although output declined, the mine remained the second largest domestic silver mine. According to the Callahan Mining Corp. annual report to stockholders, 4,147,000 ounces of silver and 1,646 tons of copper were recovered from 144,145 tons of ore. The report also showed that in the 14 years that American Smelting and Refining Co. (75 percent) and Day Mines, Inc. (25 percent), have been leasing the mine from Callahan, 1,059,000 tons of ore containing 33,880,000 ounces of silver has been extracted from the mine. Diamond drilling (10,606 feet) disclosed several new silver veins between the 3200 and the 4000 levels, and the No. 1 main hoisting shaft was deepened to the 4300 level. In addition, 6,205 feet of drifting and 2,330 feet of raising were completed. As a result of development, ore reserves at yearend were sufficient for 6 years' operation at current extraction rates.

The Dayrock mine was maintained on a standby basis, but metal price increases were insufficient to warrant renewed operations.

Smelter District—The Bunker Hill Co. resmelted 62,609 tons of dump slag that yielded 29,507 ounces of silver, 64 tons of copper, 1,495 tons of lead, and 5,305 tons of zinc. In addition to its metal content, the slag was valued as a fluxing agent in the lead smelter blast furnace charge.

Summit District—Ray Simmons operated the Bear Top mine under a lease from Merger Mines Corp. Approximately 25 tons of lead ore from the property yielded 78 ounces of silver, 10 tons of lead, and 1 ton of zinc.

Yreka District—The Bunker Hill Co. annual report to stockholders stated that 1,959,499 ounces of silver, 34,184 tons of lead, and 17,694 tons of zinc were recovered from 450,903 tons of Bunker Hill mine ore. Production by the company and four lessees (Bailey, Marr, McLin, and Thompson) was less than that of 1962. Yearend ore reserves were 1,806,731 tons, an increase of 68,670 tons over the 1962 figure. The 5-year accelerated development program, begun in 1961, fell behind schedule when work on the 3100 Crescent West Lateral (being driven to connect with a heading from the Bunker Hill mine) was suspended to permit sinking the Crescent mine's Alhambra winze. At yearend, the headings between the Crescent and Bunker Hill mines were 3,200 feet apart; a connection was scheduled for May 1965. The Bunker Hill Co. paid a dividend to stockholders, the first such payment since 1958.

Production of silver from The Bunker Hill Co. Crescent mine declined sharply (42 percent) from that of 1962. According to the company annual report, 21,442 tons of ore yielded 494,828 ounces of silver. Yearend ore reserves were 41,170 tons, 7,543 tons below the 1962 figure. Hopes for future reserve increases were hinged on developing the new 3300 level of the mine, scheduled for 1964.

The Page mine operation of American Smelting and Refining Co. continued to be one of the major lead and zinc producers in the State.

A small quantity of lead-zinc mill cleanings was shipped from the Liberal King mill.

Valley.—Antimony Gold Ores Co. processed antimony ore from the Antimony Ridge, Garnet Creek, and Sugar Creek properties in its 50-ton-per-day mill a few miles south of Yellow Pine. Concentrate was trucked from the mill to the railhead at Cascade. A small amount of mercury ore from the Hermes property was stockpiled by the company for future processing. The ore contained about 7 pounds of mercury per ton. Ore processed during the year was concentrated by flotation before being retorted.

Washington.—Iron ore was shipped from three mines—Campbell and Mortimer (Joe Holcomb) and Cudahy Mountain (George Budock). There was no activity at the Idaho-Almaden mercury mine, site of an extensive drilling program in 1962.

The Mineral Industry of Illinois

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Illinois Geological Survey, for collecting information on all minerals except fuels.

By Matthew G. Sikich [1] and Richard E. Dawes [2]

ILLINOIS mineral production in 1963 was valued at $583.9 million, a decrease of 1 percent from 1962. Decreases in total value of production of lead, natural gas, petroleum, sand and gravel, stone, and zinc more than offset increases for portland and masonry cements, clays, coal, fluorspar, lime, natural gas liquids, peat, and tripoli (amorphous silica). Mineral fuels was the major commodity group, supplying 74 percent of the State total value. Nonmetals furnished nearly 25 percent and metals about 1 percent.

A variety of minerals were produced in Illinois. In 1963, the State led in fluorspar production, ranked fourth in bituminous coal output, and was among the leading States in producing construction materials—cement, clays, lime, sand and gravel, and stone. Illinois also ranked high in the processing of mineral raw materials.

TABLE 1.—Mineral production in Illinois [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	9,145	$30,205	9,281	$30,577
Masonry—thousand 280-pound barrels	440	1,320	472	1,440
Clays—thousand short tons	1,929	4,151	1,949	4,368
Coal (bituminous)—do	48,487	186,986	51,736	196,518
Fluorspar—short tons	132,830	6,392	132,060	6,547
Lead (recoverable content of ores, etc.)—do	3,610	664	2,901	627
Natural gas—million cubic feet	10,650	1,523	9,459	1,220
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	13,315	1,023	14,939	1,077
LP gases—do	327,616	13,812	337,278	14,714
Petroleum (crude)—thousand 42-gallon barrels	78,796	234,812	[2] 73,783	[2] 219,873
Sand and gravel—thousand short tons	34,122	38,981	31,746	36,431
Stone—do	41,293	54,411	40,293	52,217
Zinc (recoverable content of ores, etc.)—short tons	27,413	6,305	20,337	4,678
Value of items that cannot be disclosed: Gem stones, lime, peat, and tripoli		12,133		13,656
Total		[3] 592,718		583,943

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Preliminary figure.
[3] Revised figure.

[1] Supervisory industry economist, Bureau of Mines, Minneapolis, Minn.
[2] Mining engineer, Bureau of Mines, Minneapolis, Minn.

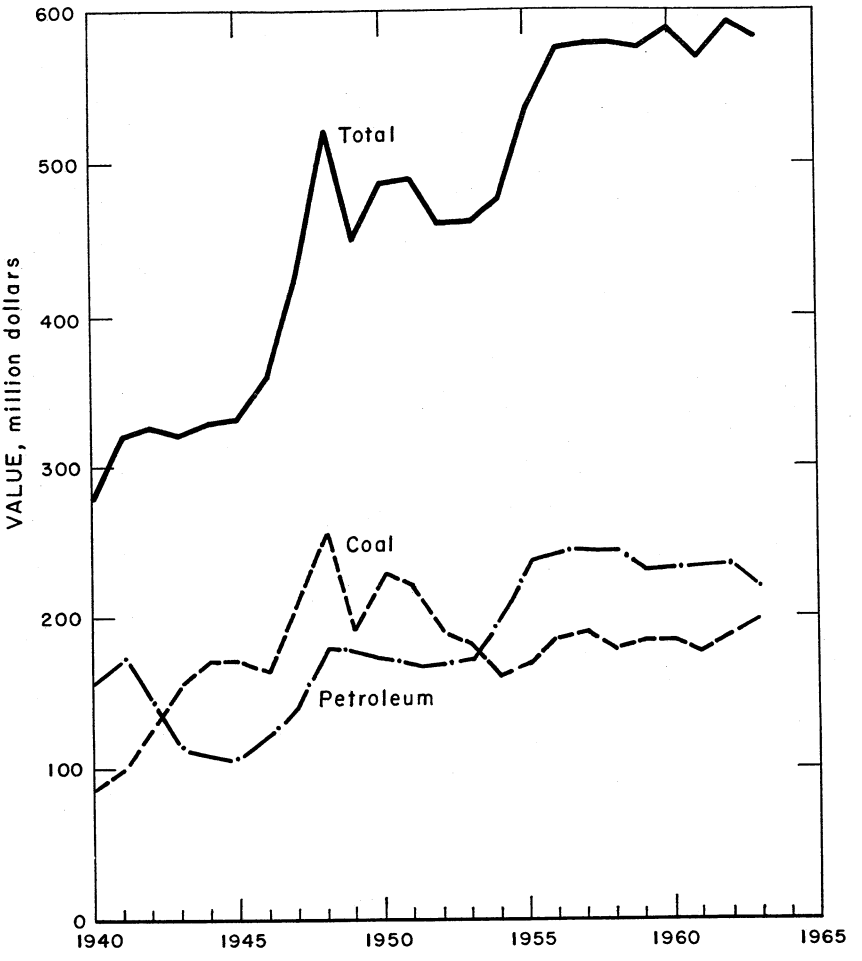


FIGURE 1.—Value of coal, petroleum, and total value of mineral production in Illinois, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Employment and Injuries.—Nearly 33.6 million man-hours were worked in Illinois mineral industries in 1963, excluding employees in the petroleum industry and officeworkers. This represented a 3-per-

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$508,258	1958	$581,825
1953	491,275	1959	581,358
1954	512,007	1960	597,911
1955	562,498	1961	577,336
1956	596,656	1962	604,512
1957	571,367	1963	596,925

cent decrease from the 34.7 million man-hours recorded for 1962. Declines in the cement, clays, lead and zinc, limestone, sand and gravel, and smelter industries were chiefly responsible for the decrease.

Twenty fatalities, 16 in the coal-mining industry, 3 at limestone and 1 at sand and gravel operations, occurred in 1963, compared with 23 for 1962. The total number of nonfatal disabling injuries decreased to 917 (preliminary figure), compared with the final figure of 918 for 1962.

Table 3 contains a summary of employment and injury data for selected State mineral industries. Certain industries are excluded from the table, primarily to avoid disclosing individual company confidential data.

TABLE 3.—Employment and injuries for selected mineral industries [1]

Year and industry	Average number of men working	Total man-hours	Total number of disabling injuries		Total number of days lost or charged	Injury frequency rate [2]	Injury severity rate [3]
			Fatal	Nonfatal			
1962:							
Cement [4]	977	2,371,334	----	2	149	.84	63
Clays [5]	1,439	2,627,259	----	56	2,158	21.31	821
Coal (bituminous)	8,567	15,419,690	21	554	163,518	37.29	10,604
Coke ovens	550	1,608,565	----	14	(6)	8.70	(6)
Fluorspar	498	975,032	----	41	1,033	42.05	1,059
Limestone [7]	2,516	4,847,916	1	114	19,027	23.72	392
Sand and gravel [8]	1,753	3,045,961	----	63	8,303	20.68	2,726
Smelters	858	2,181,875	----	31	1,020	14.21	467
1963: [9]							
Cement [4]	821	1,965,750	----	2	(6)	1.02	(6)
Clays [5]	1,308	2,368,405	----	60	(6)	25.33	(6)
Coal (bituminous)	8,300	15,620,000	16	630	(6)	41.36	(6)
Coke ovens	532	1,554,247	----	11	(6)	7.08	(6)
Fluorspar	488	966,318	----	24	(6)	24.84	(6)
Limestone [7]	2,383	4,581,083	3	85	(6)	19.21	(6)
Sand and gravel [8]	1,664	2,879,241	1	44	(6)	15.63	(6)
Smelters	682	1,991,479	----	23	(6)	11.55	(6)

[1] Excludes officeworkers.
[2] Total number of injuries per million man-hours.
[3] Total number of days lost or charged per million man-hours.
[4] Includes cement plants and quarries or pits producing raw material used in manufacturing cement.
[5] Excludes pits producing clay used in manufacturing cement.
[6] Data not available.
[7] Excludes quarries producing limestone used in manufacturing cement and lime.
[8] Excludes friable sandstone operations.
[9] Preliminary figures.

Water.—To obtain valid data concerning water use by the mineral industries for 1962, the Bureau of Mines conducted a nationwide canvass of virtually all mineral extractive and certain mineral processing industries. Cement plants, lime plants, and other manufacturing type operations were excluded. Table 4 summarizes some of the data collected for the State. As used in the table, "new water" is that entering the plant as make-up water and when added to the "recirculated water" gives the total used or required for processing. "Water discharged" is used water leaving the plant. "Water consumed" is that which leaves the plant as moisture combined or entrained in the product or lost by evaporation and no longer available for reuse in the vicinity of the plant.

In addition to data presented in table 4, an estimated 126 million gallons (3.0 million barrels) of water was used in well drilling in the State oil and gas industry, and 17.6 billion gallons (419.7 million barrels) at secondary oil-recovery operations. Data obtained for natural-gas processing plants cannot be published in order to avoid disclosing individual company confidential data.

TABLE 4.—Water statistics for selected mineral industries in 1962

(Million gallons)

Industry	New water	Water recirculated	Total water used	Water discharged	Water consumed
Coal (bituminous)	5,304	22,409	27,713	4,877	428
Limestone	1,103	57	1,160	1,073	30
Sand and gravel	6,409	10,290	16,699	6,250	160
Other nonmetals	496	169	665	487	10
Lead and zinc [1]	1,183	80	1,263	1,177	6
Total [2]	14,496	33,004	47,501	13,863	633

[1] Excludes mines and plants producing lead and/or zinc concentrates as byproducts of fluorspar operations.
[2] Data do not add to totals shown because of rounding.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Illinois ranked as the fourth largest coal-producing State in the Nation with an output of 51.7 million short tons. The 7-percent increase in tonnage and 5-percent increase in total value from that of 1962 was attributed to a 2-million ton increase in consumption by electric utilities. Approximately 31.7 million tons of coal mined in the State was used in producing electrical energy. Total shipments to general manufacturing and processing industries increased about 700,000 tons and to coke and gas plants increased about 340,000 tons. Sales to retail dealers decreased over 500,000 tons and for railroad fuel, consumption declined to about 280,000 tons. Total coal consumption in Illinois declined slightly, but nearly 75 percent of the 39.1 million tons of bituminous coal consumed in Illinois was produced within the State. Average mine value was $3.80 per ton, compared with $3.86 per ton in 1962.

Coal was produced at 108 mines in 33 counties. Data exclude mines producing less than 1,000 tons annually. Major producing counties, each with output of over 1 million tons of coal, in order of decreasing

production were Williamson, Fulton, St. Clair, Christian, Franklin, Saline, Perry, Jefferson, Montgomery, Randolph, Knox, Jackson, and Vermilion. Nine companies produced over 1 million tons each and together furnished nearly 90 percent of the total output. Peabody Coal Co. No. 10 underground mine in Christian County ranked as the largest producing bituminous coal mine in the Nation. Three other Illinois mines were among the 10 largest producing mines in the Nation.

Strip mines supplied nearly 53 percent of the total production and underground mines the remainder. Output from strip mines increased 11 percent and from underground mines 2 percent, compared with 1962.

Fifty-three plants cleaned 88 percent of the State coal output. All but a minor fraction of the underground production was cut by machines and mechanically loaded. Loading equipment included 96 mobile loaders, 41 continuous miners, and 5 duckbills or self-loading conveyors. Stripping and loading equipment at strip mines included 163 power shovels, draglines, and wheel excavators. Nearly 83 percent of the total State output was shipped to consumers by rail, over 11 percent by truck, and about 6 percent by waterways. A small quantity was consumed at the mines.

TABLE 5.—Coal (bituminous) production in 1963, by counties

(Excludes mines producing less than 1,000 short tons)

County	Number of mines operated		Production (short tons)			Value
	Underground	Strip	Underground	Strip	Total	
Adams		1		33,509	33,509	$234,285
Bureau		1		321,250	321,250	(1)
Christian	1		5,351,930		5,351,930	(1)
Douglas	1		527,418		527,418	(1)
Franklin	3		5,227,110		5,227,110	(1)
Fulton		16		6,272,588	6,272,588	25,048,588
Gallatin	2		50,622		50,622	176,510
Greene		1		3,868	3,868	21,682
Grundy		1		321,562	321,562	(1)
Henry	1		102,128		102,128	(1)
Jackson	1	4	79,130	1,181,307	1,260,437	(1)
Jefferson	1	1	2,699,311	7,512	2,706,823	(1)
Knox		2		1,520,595	1,520,595	(1)
Logan	1		19,826		19,826	98,337
Macoupin	1		286,787		286,787	1,098,403
Madison	2		580,240		580,240	2,356,617
Marion	1		6,398		6,398	23,676
Menard	1		3,164		3,164	19,578
Mercer	1	1	60,770	2,528	63,298	(1)
Montgomery	1		2,020,981		2,020,981	(1)
Peoria	2	5	16,300	926,352	942,652	4,621,014
Perry	1	3	1,410	3,524,963	3,526,373	(1)
Randolph	1	2	858,494	1,037,867	1,896,361	(1)
St. Clair	4	3	1,250,756	4,495,233	5,745,989	20,218,847
Saline	2	10	1,474,890	2,327,976	3,802,866	14,264,976
Sangamon	2		97,404		97,404	482,780
Schuyler		1		590,809	590,809	(1)
Stark		1		536,510	536,510	(1)
Vermilion	3	3	47,341	1,106,574	1,153,915	(1)
Wabash		1		3,076	3,076	12,704
Washington	1		22,981		22,981	(1)
Will		1		335,187	335,187	(1)
Williamson	10	6	3,663,615	2,738,044	6,401,659	24,269,607
Total	44	64	24,449,006	27,287,310	51,736,316	196,517,863

(1) Figure withheld to avoid disclosing individual company confidential data; included in total.

In mid-1963, Carmac Coal Co. and Delta Coal Corp. merged with Thunderbird Collieries Corp. Peabody Coal Co. acquired operations owned or controlled by the Midland Electric Coal Corp., principally in the Galesburg-Peoria area.

Central Illinois Public Service Co. and Truax-Traer Coal Division, Consolidation Coal Co., Inc., began constructing a new mine-mouth electric power complex near Hillsboro. Completion of the project was scheduled for 1965.

Midland Electric Coal Corp. planned to open a new strip mine near Percy to supply 40 million tons of coal to Commonwealth Edison Co. over the next 10 years. Completion of the project was scheduled for late 1964. The new Captain mine and adjacent Streamline mine will both be operated by Southwestern Illinois Coal Corp. and will be the largest strip mine complex in the Nation. Special unit trains will move the coal 300 miles to Commonwealth Edison's power generating plant at Joliet.

Coke.—Production at five plants of approximately 1,871,000 short tons of coke, valued at $35.4 million, decreased 2 percent in quantity and 3 percent in value compared with 1962. About 1,766,000 tons was used by producing companies in blast furnaces.

Recovery of nearly 170,000 tons of coke breeze valued at $1,191,000 at coke plants represented increases of 10 percent in tonnage and 14 percent in value over 1962 recoveries. Over 108,000 tons of coke breeze, a 33-percent increase over 1962, was used by producers in agglomerating iron ore. Other products of coke-oven plants included coke-oven gas, ammonia, tar, crude light oil, and light-oil derivatives. Youngstown Sheet & Tube Co. did not activate their coke ovens in 1963.

Peat.—Peat production increased substantially in 1963. Output was reported by two companies in Cook and Kane Counties. Reed-sedge and humus types were sold in bulk form as soil conditioners.

Petroleum, Natural Gas, and Natural Gas Liquids.—Crude petroleum output decreased 6 percent in quantity and value to comprise nearly 38 percent of the total value of State mineral production. Most of the production came from oilfields in the southeastern part of the State. Water-flood oil production accounted for about two-thirds of the total output.

The Illinois State Geological Survey reported 1,878 wells were completed in 1963, of which 898 were producing oil wells, 32 were gas wells, 530 were dry holes in pools, and 418 were unsuccessful wildcats. Total footage drilled was 3,860,400, of which 51 percent was in producing wells. Data do not include service wells, natural-gas storage wells, or old wells worked over.

Estimated proved crude-oil reserves on December 31 were 417 million barrels, according to the American Petroleum Institute. Nearly 19 percent of crude petroleum production came from the Loudon field in Effingham and Fayette Counties.

Marketed production of natural gas decreased 11 percent in quantity and 20 percent in value. Liquefied petroleum gas output increased 3 percent in quantity and 6 percent in value. Production of natural gasoline increased 12 percent in quantity and 5 percent in value.

The American Gas Association estimated proved recoverable reserves of natural gas liquids at 2 million barrels at yearend.

A Federal Area Redevelopment Administration loan was approved in mid-1963 to help the Pana Refining Co. reopen and expand its gasoline products plant at Pana.

Confirmation wells in the East Wapella field, discovered in late 1962, established this new pool as DeWitt County's first oil production source. The discovery was about 25 miles north of previously established production along the north-central margin of the Illinois Basin. Production was from Silurian and Devonian formations.[3]

TABLE 6.—Crude petroleum production, by fields[1]

(Thousand barrels)

Field	1959	1960	1961	1962	1963[2]
Albion	1,113	888	863	772	775
Benton	529	467	442	565	553
Centralia	2,160	1,420	995	1,238	875
Clay City	7,269	7,470	6,683	6,495	5,725
Dale	1,979	2,506	3,136	2,852	2,525
East Inman	1,126	746	495	593	560
Johnsonville	1,698	1,438	1,433	1,720	1,350
Loudon	12,586	12,628	13,356	14,925	14,125
New Harmony	4,758	5,252	5,246	5,333	5,100
Old Illinois (Bridgeport, Casey and Robinson-Stoy)	9,461	12,225	12,483	11,275	11,150
Phillipstown	606	653	622	665	525
Roland	1,860	1,545	1,304	1,175	1,100
Sailor Springs	1,378	1,382	1,281	1,216	1,400
Salem	6,926	8,482	9,659	10,590	10,100
Other fields[3]	23,278	20,239	18,820	19,382	17,920
Total	76,727	77,341	76,818	78,796	73,783

[1] Based on Oil and Gas Journal data adjusted to Bureau of Mines total.
[2] Preliminary figures.
[3] Bureau of Mines figures.

NONMETALS

Cement.—Five companies with plants in LaSalle, Lee, and Massac Counties produced portland and masonry cements. Shipments of portland cement increased over 1 percent in both quantity and value. Average value per barrel decreased to $3.29. Total production of portland cement was about two-thirds of annual finished portland cement capacity. Slightly less than 97 percent of production was of types I and II (general-use and moderate-heat); the remainder, high-early-strength and special-use types.

Sales to ready-mixed concrete companies accounted for approximately two-thirds of the total shipments. This was a decrease of slightly over 1 percent in quantity. Highway contractors and concrete product manufacturers accounted for 15 percent and 13 percent, respectively, of the shipments. Shipments to highway contractors decreased 3 percent, but shipments to concrete product manufacturers increased 26 percent. Sales of masonry cement increased 7 percent in quantity and 9 percent in value.

[3] Oil and Gas Journal. Wapella East Discovery Should Bolster Reef Hunt in Central Illinois. V. 61, No. 21, May 27, 1963, pp. 144–147.

Nearly 94 percent of shipments were in bulk, the remainder in paper bags. Approximately 70 percent of shipments were by truck and the rest by rail.

Over 73 percent of the portland cement and nearly 43 percent of the masonry cement shipments were distributed within the State. Wisconsin was the next largest consumer with nearly 18 percent of the portland cement shipments and approximately 39 percent of the masonry cement shipments. Indiana, Iowa, and Tennessee each received 2 percent of the shipments of portland cement. Over 11 percent of masonry cement shipments went to Tennessee and 4 percent to Iowa. Other shipments were to Missouri, Arkansas, Kentucky, Mississippi, Minnesota, and Michigan.

Over 2.6 million tons of limestone was used for the manufacture of cement. Approximately 300,000 tons of other raw materials such as clay, shale, gypsum, slag, sand, and anhydrite also were consumed.

Nearly 260 million kilowatt hours of electrical energy was used and about evenly distributed between purchased and home-generated sources. All five plants used the dry process of production.

Lehigh Portland Cement Co. closed its Oglesby plant late in 1963.

Missouri Portland Cement Co. started production in mid-1963 at its new 3-million barrel cement plant at Joppa in Massac County. Limestone for the plant was quarried and crushed near Cave-in-Rock, in Hardin County, then barged approximately 70 miles on the Ohio River to the Joppa plant.

TABLE 7.—Finished portland cement produced and shipped

(Thousand 376-pound barrels and thousand dollars)

Year	Active plants	Production	Shipped from mills	
			Quantity	Value
1954–58 (average)	4	8,940	8,739	$24,954
1959	4	9,559	9,486	30,158
1960	4	9,270	8,770	29,321
1961	4	8,757	8,595	28,301
1962	4	9,081	9,145	30,205
1963	5	9,465	9,281	30,577

Cement distribution centers were constructed by the Missouri Portland Cement Co. near Peoria and by Lehigh Portland Cement Co. near Plainfield and Decatur.

Clays.—Fire clay and miscellaneous clay and shale production increased 1 percent in quantity and 5 percent in value. Fifty-five percent of each clay type was used in manufacturing heavy clay products. This represented an 8-percent increase in fire clay consumption and a 2-percent decrease in miscellaneous clay and shale consumption. Miscellaneous clay and shale consumption for lightweight aggregate increased less than 1 percent.

Clay sales were 196,000 short tons valued at $1.2 million, increases of 14 percent in quantity and 10 percent in value over 1962 sales. The remainder of the clay production was consumed by producing companies. Production was reported from 25 counties. Fire clay production was reported by 11 companies in Greene, Grundy, LaSalle, McDonough, Marshall, Massac, and Rock Island Counties.

TABLE 8.—Clays sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Fire clay		Miscellaneous clay		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	456	$1,474	1,719	$3,032	2,175	$4,506
1959	322	2,158	1,908	2,792	2,229	4,950
1960	359	2,378	1,997	3,101	2,357	5,479
1961	263	1,764	1,719	2,402	1,982	4,166
1962	317	1,737	1,612	2,414	1,929	4,151
1963	332	1,712	1,617	2,656	1,949	4,368

Fluorspar.—Illinois supplied 66 percent of the total domestic output of fluorspar to rank first among the 6 fluorspar-producing States. Shipments decreased less than 1 percent in quantity but increased 2 percent in value. Sales of acid grade decreased 2 percent but still accounted for 70 percent of total sales. Sales of ceramic grade increased 7 percent to represent 28 percent of total sales. Metallurgical grade fluorspar sales decreased substantially and accounted for 2 percent of total sales.

All finished fluorspar was produced in Hardin County, where over 400,000 tons of crude ore was processed to produce nearly 128,000 tons of finished fluorspar. Some byproduct lead and zinc concentrates also were produced.

The Illinois State Geological Survey made a detailed aeromagnetic survey of the fluorspar district in an area-wide exploration program.

Production of pelletized fluorspar concentrate was extended to improve marketability.

Gem Stones.—Specimens of glacial agates, fluorspar, and other minerals were obtained principally for private collections.

Lime.—Quicklime and hydrated lime production increased 11 percent in quantity and 13 percent in value. Over 58 percent of the output was for refractory use, 36 percent for chemical and industrial use, and nearly 6 percent for construction use. A small quantity was sold for agricultural purposes.

Perlite.—Five companies with plants in Champaign, Cook, DeKalb, Kankakee, and Will Counties processed crude perlite from mines in New Mexico. Processed material sold or used increased threefold in quantity and value. The increased quantity was attributed to the Joliet plant of the Celite Division of Johns-Manville Perlite Corp. for use in insulating board.

Loose fill insulation increased 28 percent in quantity, filter aid use decreased 19 percent, and concrete aggregate use decreased 8 percent. The remainder was used in building plaster, filler, and soil conditioning.

Sand and Gravel.—Total production of sand and gravel decreased 7 percent in both quantity and value. This dropped Illinois to seventh place in the Nation for quantity and fifth place for value of sand and gravel production. Production was reported in 79 counties from 252 commercial and 141 Government-and-contractor operations. Sand and gravel for paving decreased nearly 25 percent, but this was

almost offset by a 23-percent increase for building use. The two uses represented nearly 82 percent of the total sales. Sales of industrial sands increased 3 percent to nearly 2.9 million tons. Output for fill increased approximately 17 percent to represent almost 8 percent of total sales. Nearly 90 percent of shipments were by truck, with the remainder by rail with the exception of 0.5 percent by water.

Production of over 1 million tons each in Bureau, Cook, Grundy, Kane, Lake, LaSalle, McHenry, Peoria, Tazewell, Will, and Winnebago Counties represented nearly 70 percent of the total output from the State. Major producers were Chicago Gravel Co.; Consumers

TABLE 9.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Glass	1,438	$3,381	1,431	$3,400
Molding	[1] 652	[1] 2,111	749	2,386
Building	5,124	4,570	6,330	5,732
Paving	7,149	6,558	4,598	4,147
Railroad ballast	129	142	[2]	[2]
Engine	19	18	[2]	[2]
Filtration	10	26	[2]	[2]
Fill	1,432	748	[2]	[2]
Ground [3]	[1] 477	[1] 4,162	181	1,901
Undistributed [4]	308	1,473	2,210	3,699
Total	[5] 16,737	[5] 23,190	[5] 15,500	[5] 21,266
Gravel:				
Building	4,164	3,890	5,126	4,881
Paving	10,869	10,395	8,234	8,398
Railroad ballast	93	94	148	154
Fill	674	407	806	474
Other	323	255	244	193
Total	16,123	15,041	14,558	14,100
Total sand and gravel	[5] 32,861	38,231	30,058	35,366
Government-and-contractor operations:				
Sand:				
Building	7	5	[6]	[6]
Paving	244	122	299	163
Fill	1	[6]	10	5
Total	252	127	309	168
Gravel:				
Paving	1,009	623	1,379	896
Fill	1	[6]	----	----
Total	1,010	623	1,379	896
Total sand and gravel	[5] 1,261	750	[5] 1,689	1,064
All operations:				
Sand	16,989	[5] 23,316	15,809	[5] 21,435
Gravel	17,133	15,664	15,937	14,996
Grand total	34,122	[5] 38,981	31,746	36,431

[1] Revised figure.
[2] Included with "Undistributed" to avoid disclosing individual company confidential data.
[3] Includes abrasive, chemical, enamel, filler, foundry, glass, pottery, porcelain, tile, and other ground sands.
[4] Includes sand for fire or furnace (1962), oil (hydrafrac), blast, other construction and industrial uses (1962-63), grinding and polishing (1963), and items indicated by footnote 2.
[5] Data do not add to total shown because of rounding.
[6] Less than 500.

Co., Division of Vulcan Materials Co.; Crystal Lake Trucking & Excavating Co.; Elmhurst-Chicago Stone Co.; McGrath Sand & Gravel Co.; Manley Sand Division, Martin Marietta Corp.; Material Service Division of General Dynamics Corp.; Ottawa Silica Co.; and Wedron Silica Co.

Stone.—Total production consisted primarily of limestone, with only a small quantity of sandstone from Alexander County reported used for refractory purposes. Limestone production decreased 2 percent in quantity and 4 percent in value. Over 72 percent of the production was used for concrete and roadstone, an 11-percent decrease compared with 1962. Twelve percent of the total production was for agricultural purposes, an increase of over 30 percent. Nearly 7 percent of the production was used in the manufacture of cement, an increase of 4 percent in quantity. Production of dimension stone decreased to about one-quarter of the 1962 output.

Over 94 percent of the crushed and broken stone was shipped by truck, 5 percent by rail, and the remainder by water.

TABLE 10.—Limestone sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough construction, thousand short tons	(1)	(1)		
Rubble, do.	1	$5	2	$12
Sawed stone [2], thousand cubic feet			(1)	(1)
House stone veneer, do.	(1)	(1)	(1)	(1)
Flagging, do.	(1)	(1)	9	8
Total, approximate thousand short tons [3]	18	167	5	117
Crushed and broken:				
Riprap, thousand short tons	319	386	283	404
Concrete aggregate and roadstone, do.	32,747	43,398	29,105	37,356
Railroad ballast, do.	293	294	344	353
Agriculture, do.	3,713	5,334	4,841	7,053
Asphalt, do.	107	465	119	471
Cement, do.	2,565	1,773	2,665	2,044
Other [4], do.	1,530	2,588	2,930	4,413
Total, do.	[5] 41,275	[5] 54,237	[5] 40,288	52,094
Grand total, do.	[5] 41,292	[5] 54,405	[5] 40,292	52,211

[1] Figure withheld to avoid disclosing individual company confidential data; included in total.
[2] Excludes house stone veneer.
[3] Average weight of 170 pounds per cubic foot used to convert cubic feet to short tons.
[4] Includes limestone for metallurgical, fertilizer, whiting or whiting substitute, dust for coal mines, mineral food, poultry grit, stone sand, lime, chemical, and other uses.
[5] Data do not add to total shown because of rounding.

Production of limestone was reported from 60 counties. Sixty-two percent of the State total crushed and broken limestone production came from 9 counties—Cook, Kankakee, LaSalle, Lee, Livingston, Randolph, Rock Island, St. Clair, and Will. Production from Cook County represented nearly a third of the total State production. Leading producers were Allied Chemical Corp.; Columbia Quarry Co.; Consumers Co., Division of Vulcan Materials Co.; Dolese & Shepard Co.; East St. Louis Stone Co.; Elmhurst-Chicago Stone Co.; Lehigh Stone Co.; Material Service Division of General Dynamics Corp.; and Mississippi Lime Co.

The plant of the Lincoln Stone Co. near Joliet was destroyed by fire in February.

Sulfur.—Production of elemental sulfur increased 15 percent in quantity and 10 percent in value. The Pure Oil Co. used the Modified Claus process to recover sulfur at its Lemont refinery in Will County. The Anlin Company of Illinois used the Amine Gas Purification and Modified Claus processes to recover sulfur at its Madison County plant.

Tripoli (Amorphous Silica).—Production of crude material increased 4 percent in quantity and 11 percent in value. Total sales of prepared material increased 6 percent in quantity and 9 percent in value. Prepared material was used for abrasives, filler, and other purposes. Production was reported from Alexander County by Ozark Minerals Co. and Tamms Industries Co.

Vermiculite.—Sales of exfoliated vermiculite increased 1 percent in quantity and 6 percent in value. Crude material was shipped from Montana and South Carolina to the plants of Zonolite Division, W. R. Grace & Co. in Cook County; Mica Pellets, Inc., in De Kalb County; and International Vermiculite Co. in Macoupin County. Processed material was used primarily for insulation and concrete and plaster aggregates.

METALS

Lead and Zinc.—Lead and zinc production, in terms of recoverable metals, decreased 20 and 26 percent, respectively, from 1962 quantities. Total value of lead production decreased about 6 percent and zinc production value decreased 26 percent. The primary reason for the decrease in quantity was Tri-State Zinc, Inc., discontinuing northern Illinois operations at its Amelia mine in February and at its Gray mine in April. These closings left The Eagle-Picher Co. as the only producer in northern Illinois. Three companies in southern Illinois, Aluminum Company of America, Minerva Oil Co., and Ozark-Mahoning Co., recovered lead and zinc as byproducts of fluorspar operations.

Average weighted yearly prices used to calculate total values of lead and zinc production in 1963 were 10.8 cents per pound for lead and 11.5 cents per pound for zinc. Prices in 1962 were 9.2 cents for lead and 11.5 cents for zinc.

New Jersey Zinc Co.'s Depue plant completed expansion of slab zinc capacity by adding three vertical retort furnaces at the existing plant. Five new zinc dust furnaces were also added.

Pig Iron and Steel.—Nearly 4.5 million short tons of pig iron, a 5-percent decrease from 1962, was shipped from Illinois blast furnaces or consumed by producing companies. Estimated total value of the output was $261.1 million. Blast furnaces were operated in Chicago and Granite City by five companies. Of the 22 blast furnaces in the State, 11 were out-of-blast the entire year, 9 part of the year, and only 2 operated throughout 1963. Youngstown Sheet & Tube Co. blast furnaces were idle the entire year.

Over 5.8 million short tons of domestic iron and manganiferous ores, excluding agglomerates, was consumed in Illinois blast and steel furnaces and agglomerating plants. In addition, over 1 million short tons of iron-ore pellets and 681,000 tons of foreign iron ore, including

TABLE 11.—Mine production of silver, lead, and zinc, in terms of recoverable metals

Year	Mines producing	Materials sold or treated [1] (short tons)	Silver		Lead		Zinc		Total value
			Troy ounces	Value	Short tons	Value	Short tons	Value	
1954–58 (average)	20	830,239	1,163	$1,053	3,238	$933,817	21,458	$5,055,160	$5,990,030
1959	22	930,265	--------	--------	2,570	591,100	26,815	6,167,450	6,758,550
1960	22	1,015,581	--------	--------	3,000	702,000	29,550	7,623,900	8,325,900
1961	20	965,541	--------	--------	3,430	706,580	26,795	6,162,850	6,869,430
1962	17	970,900	--------	--------	3,610	664,240	27,413	6,304,990	6,969,230
1963	13	750,930	--------	--------	2,901	626,616	20,337	4,677,510	5,304,126

[1] Data include fluorspar ore from which lead and/or zinc were recovered as follows: 1954—202,478 tons; 1955—309,311 tons; 1956—336,635 tons; 1957—360,406 tons; 1958—401,562 tons; 1959—297,252 tons; 1960—380,395 tons; 1961—368,283 tons; 1962—399,742 tons; and 1963—400,283 tons.

TABLE 12.—Mine production of lead and zinc in 1963, by months, in terms of recoverable metals

(Short tons)

Month	Lead	Zinc	Month	Lead	Zinc
January	265	2,190	August	200	1,665
February	315	2,030	September	175	1,390
March	295	2,005	October	170	1,375
April	480	1,870	November	175	1,476
May	255	1,945	December	171	1,476
June	200	1,530			
July	200	1,385	Total	2,901	20,337

33,000 tons of sinter from Canada, were consumed. Over 3 million tons of sinter was produced at consuming furnaces. Approximately 4.2 million short tons of agglomerates (sinter and pellets), 3.3 million tons of coke, and 1.8 million tons of limestone and dolomite were consumed. Data for nonintegrated steel plants are not included.

According to the American Iron & Steel Institute, steel production from furnaces operated by 13 companies in Illinois increased about 7 percent to 9,214,336 short tons.

Other Metals.—The American Potash & Chemical Corp. at West Chicago manufactured refined thorium compounds from monazite concentrate. The company also produced rare-earth compounds.

Small but valuable quantities of certain metals, such as cadmium, gallium, and germanium are present in some ores mined in the State. These were recovered in later processing stages at plants in Illinois or other States.

REVIEW BY COUNTIES

Mineral production in 1963, excluding liquid fuels and natural gas, was reported in 96 of the 102 counties. Of this group the two leading counties in mineral output were LaSalle County with $33.3 million and Cook County with $30.4 million. Fulton, St. Clair, and Williamson Counties each had reported mineral output values of over $20 million. Other leading counties with mineral output exceeding $10 million were Christian, Franklin, Jefferson, Lee, Perry, and Saline. Total

reported value of mineral production increased in 45 counties and decreased in 52 counties from 1962 values.

Some counties are not included in the text of this section. However, counties with production in 1963 and minerals produced in each, except for liquid fuels and natural gas, are listed in table 13. Production values that could not be attributed to a county source are included under "Undistributed." Only those coal producers whose annual output was 1,000 tons or more are included, unless otherwise stated.

TABLE 13.—Value of mineral production in Illinois, by counties[1]

County	1962	1963	Minerals produced in 1963 in order of value
Adams	$2,141,948	$2,057,686	Stone, lime, coal, sand and gravel.
Alexander	222,725	221,444	Tripoli, sand and gravel, stone.
Bond	244,153	217,795	Sand and gravel, clays, stone.
Boone	160,560	150,997	Sand and gravel, stone.
Brown	129,672	78,274	Stone, clays, sand and gravel.
Bureau	2,333,585	2,293,975	Coal, sand and gravel, clays.
Calhoun	103,792	41,400	Stone, sand and gravel.
Carroll	220,961	249,590	Do.
Cass	9,729	3,327	Sand and gravel.
Champaign	325,114	360,329	Do.
Christian	(2)	(2)	Coal, stone.
Clark	616,739	647,492	Stone, sand and gravel.
Clay	(2)	149,250	Stone.
Clinton	(2)	(2)	Stone, sand and gravel.
Coles	686,367	684,773	Do.
Cook	29,975,905	30,373,014	Stone, lime, sand and gravel, clays, peat.
Crawford	121,384	(2)	Sand and gravel.
Cumberland	(2)	(2)	Do.
De Kalb	529,980	485,337	Sand and gravel, stone.
De Witt	(2)	(2)	Sand and gravel.
Douglas	(2)	(2)	Coal.
Du Page	(2)	(2)	Stone, sand and gravel.
Edgar		2,195	Sand and gravel.
Edwards	22,140		
Fayette	194,988	333,011	Sand and gravel, stone, clays.
Ford	184,780	156,940	Sand and gravel.
Franklin	(2)	(2)	Coal.
Fulton	21,278,961	25,443,282	Coal, sand and gravel.
Gallatin	412,525	(2)	Sand and gravel, coal.
Greene	516,058	501,635	Stone, clays, coal.
Grundy	5,324,577	4,425,571	Coal, sand and gravel, clays.
Hancock	417,903	413,592	Stone, sand and gravel.
Hardin	9,717,325	10,218,920	Fluorspar, zinc, stone, lead, sand and gravel.
Henderson	321,969	349,508	Stone, sand and gravel.
Henry	907,517	580,478	Coal, stone, sand and gravel.
Iroquois	(2)	(2)	Sand and gravel.
Jackson	(2)	4,660,976	Coal, stone, sand and gravel.
Jefferson	(2)	(2)	Coal, stone.
Jersey	(2)	221,903	Stone.
Jo Daviess	4,463,231	3,107,295	Zinc, stone, sand and gravel, lead.
Johnson	987,042	1,279,250	Stone, sand and gravel.
Kane	2,814,933	2,782,137	Sand and gravel, stone, peat.
Kankakee	2,340,064	2,072,334	Stone, clays, sand and gravel.
Kendall	306,445	289,100	Stone, sand and gravel.
Knox	(2)	(2)	Coal, stone, clays, sand and gravel.
Lake	1,347,871	838,141	Sand and gravel, clays.
La Salle	36,432,025	33,263,700	Cement, sand and gravel, stone, clays.
Lawrence	230,990	243,563	Sand and gravel.
Lee	(2)	(2)	Cement, stone, sand and gravel, clays.
Livingston	2,217,613	2,283,858	Stone, clays, sand and gravel.
Logan	692,823	691,954	Sand and gravel, stone, coal.
McDonough	352,646	(2)	Stone, clays, sand and gravel.
McHenry	2,973,520	3,022,075	Sand and gravel, stone.
McLean	552,904	(2)	Sand and gravel.
Macon	(2)	(2)	Do.
Macoupin	1,292,969	1,098,403	Coal.
Madison	3,915,198	3,994,487	Coal, stone, sand and gravel.
Marion	(2)	(2)	Stone, coal.
Marshall	238,527	275,592	Sand and gravel, clays.
Mason	(2)	(2)	Sand and gravel.
Massac	(2)	(2)	Cement, stone, clays, sand and gravel.
Menard	(2)	(2)	Stone, coal, clays.
Mercer	378,202	522,368	Coal, stone, sand and gravel, clays.
Monroe	(2)	(2)	Stone.
Montgomery	(2)	(2)	Coal, stone, sand and gravel.

See footnotes at end of table.

TABLE 13.—Value of mineral production in Illinois, by counties [1]—Continued

County	1962	1963	Minerals produced in 1963 in order of value
Ogle	$1,751,383	$1,822,627	Sand and gravel, stone.
Peoria	7,553,387	7,194,309	Coal, sand and gravel, stone.
Perry	(2)	(2)	Coal.
Piatt	(2)	(2)	Sand and gravel.
Pike	643,550	635,028	Stone, sand and gravel.
Pope	37,280	4,982	Sand and gravel.
Pulaski	(2)	(2)	Clays, stone, sand and gravel.
Putnam	2,494	79,048	Sand and gravel.
Randolph	7,713,545	7,736,701	Coal, stone, sand and gravel.
Richland		537	Sand and gravel.
Rock Island	2,185,727	2,181,000	Stone, sand and gravel, clays.
St. Clair	21,091,864	23,425,360	Coal, stone, sand and gravel, clays.
Saline	13,278,716	14,264,976	Coal.
Sangamon	968,805	1,146,579	Sand and gravel, coal, clays.
Schuyler	(2)	(2)	Coal, stone, sand and gravel.
Scott	343,611	233,803	Stone, clays.
Shelby	(2)	(2)	Stone, sand and gravel.
Stark	(2)	(2)	Coal, sand and gravel.
Stephenson	286,443	338,684	Stone, sand and gravel.
Tazewell	1,626,282	1,241,035	Sand and gravel, clays.
Union	951,452	1,196,885	Stone, sand and gravel.
Vermilion	5,938,797	6,307,652	Coal, stone, clays, sand and gravel.
Wabash	212,688	191,267	Sand and gravel, coal.
Warren	(2)	146,273	Stone.
Washington	(2)	(2)	Stone, coal.
Wayne		(2)	Sand and gravel.
White	184,883	185,783	Do.
Whiteside	377,113	338,055	Stone, sand and gravel.
Will	7,921,964	6,629,559	Sand and gravel, stone, coal.
Williamson	21,990,223	24,270,859	Coal, sand and gravel.
Winnebago	2,088,679	2,154,263	Sand and gravel, stone.
Woodford	183,760	(2)	Sand and gravel.
Undistributed	[3] 356,726,636	341,130,784	
Total	[3] 592,718,000	583,943,000	

[1] Excludes petroleum, natural gas, natural gas liquids, and some sand and gravel for which data by counties are not available; included with "Undistributed." The following counties did not report production: Effingham, Hamilton, Jasper, Morgan, and Moultrie.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Revised figure.

Adams.—Limestone from three underground mines and six quarries was produced for various uses. Black White Limestone Co.; Marblehead Lime Co., Division of General Dynamics Corp.; and Menke Stone & Lime Co. operated stationary plants in connection with their underground mines. Missouri Gravel Co. operated portable plants at the Reinebach, Richfield, and Spring Valley quarries. Western Illinois Stone Co. operated portable plants at its Nos. 7, 8, and 9 quarries. Marblehead Lime Co. and Menke Stone & Lime Co. also produced quicklime and hydrated lime near Quincy. Blick's Sand Co. and Quincy Sand Co. produced sand and gravel near Quincy for building, paving, fill, and other uses. Blick's Sand Co. operated a portable plant and Quincy Sand Co. operated a dredge.

Triple S Mines, Inc., produced coal from a strip mine near Augusta for local consumption. Total production of 33,500 tons was cleaned by jigging.

Alexander.—Tripoli (amorphous silica) was produced by Ozark Minerals Co. and Tamms Industries Co. from underground mines near Elco and Tamms. Prepared material was used for abrasives, filler, and other uses. Sand and gravel was produced for building, paving, and railroad ballast by the dredge operation of H. H. Halliday Sand Co. near Cairo. Paving gravel was produced by the county highway department. Sandstone was mined by Western Fire Brick Co. from

an underground mine near Elco. The material was shipped by rail to the company plant at Granite City for processing into refractory material.

Bond.—Sand and gravel was produced by Greenville Gravel Co., Inc., and by Pruitt & Basler Sand Pit near Greenville from stationary plants as well as by Munie Gravel Pit near Keyesport from both stationary and portable plants. Material was used for building, paving, fill, and other uses. Clay was produced near New Douglas by Richards Brick Co. for building brick manufactured at its plant near Edwardsville, Madison County. Limestone for road construction was produced by Bond Stone Co. from its quarry and stationary plant near Sorento.

Brown.—Crushed limestone was produced by Brown County Stone Co. and Missouri Gravel Co. from quarries near Mount Sterling. Output was for roadstone, agricultural use, and riprap. Miscellaneous clay was produced by Frederic Brick & Tile Co. near Mount Sterling for use in manufacture of drain tile. The Brown County Stone Co.'s sand and gravel operation near Mount Sterling was idle throughout the year.

Bureau.—The Midland Electric Coal Corp. (acquired by Peabody Coal Co. in mid-1963) produced coal from a strip mine near Mineral and cleaned it at the company plant in Henry County. Coal from the company's Mecco mine in Knox County was also cleaned at this plant. Shipments were primarily by rail.

Nine commercial operators, the county highway department, and contract operations for the State highway department and the city of Princeton produced over 1.1 million tons of sand and gravel for building, paving, fill, and other uses. Production was from both fixed and portable plants. Sheffield Shale Products Co. produced miscellaneous clay near Sheffield for manufacturing building brick and other heavy clay products. The company ceased operations because it could no longer be competitive.

New Jersey Zinc Co. added three vertical retort furnaces and five new zinc dust furnaces to its Depue plant to increase productive capacity of both slab zinc and zinc dust.

Champaign.—At their Champaign plant, Ryolex Corp. expanded crude perlite mined in New Mexico for use as a plaster additive. Approximately 380,000 tons of sand and gravel was produced by four commercial companies for building, paving, fill, and other uses. Plants were operated near Champaign, Mahomet, and Ludlow. An additional 33,000 tons of paving material was produced under contract for the State highway department.

Christian.—Peabody Coal Co. mined coal at its No. 10 underground mine near Pawnee, the largest producing bituminous coal mine in the United States. Production increased nearly 2 percent over that of 1962. Christian County ranked first in underground coal production in the State and fourth in total coal output. Over 96 percent of the total output was shipped by rail. Fifty-one percent of the coal was cleaned by jigging.

Tri County Stone Co. produced limestone at a fixed plant near Nokomis for concrete aggregate, roadstone, and agricultural uses.

Clark.—Crushed limestone was produced by Casey Stone Co. from

two quarries near Casey, and by Quality Lime Co. Corp. from a quarry near Marshall for concrete aggregate, roadstone, and agricultural uses. Both companies operated stationary plants. Sand and gravel was produced by Lawrence Sand & Gravel Co. from a stationary plant near West Union and by Marshall Gravel Co. from a dredging operation near Marshall. The material was for building, paving, and fill. The State highway department contracted for paving gravel.

Coles.—Crushed limestone was produced by Charleston Stone Co. near Charleston and the Olen Humphres Quarry near Ashmore for roadstone and agricultural uses. Sand and gravel was produced by the Olen Humphres Quarry from a portable plant near Charleston for use in paving material. Mattoon Sand & Gravel Co. produced sand and gravel from a stationary plant near Mattoon for building, paving, and fill. The Boyd Gravel Pit was idle throughout the year. The State highway department contracted for paving gravel.

Cook.—Mineral production value increased to over $30 million. Limestone led in value with over $16 million. Producers were Consumers Co., Division of Vulcan Materials Co., with quarries near Hillside, Lemont, and McCook; Dolese & Shepard Co. with a quarry near Hodgkins; R. P. Donohoe Co., Inc., with a quarry near Lemont; and Material Service Division of General Dynamics Corp. with quarries near Chicago, Lyons, McCook, and Thornton. Processed material was used as concrete aggregate, roadstone, metallurgical flux, railroad ballast, agricultural limestone, lime, and refractory material. Elroy & Son, with quarries near Lemont, discontinued business in 1963. Lime was produced by two companies operating three plants. Marblehead Lime Co. produced quicklime and hydrated lime at plants in South Chicago and Thornton. Standard Lime & Cement Co., Division of Martin Marietta Corp., produced quicklime at its operations near McCook for refractory use. Over 1 million tons of sand and gravel was produced by five companies. Chicago Gravel Co., operating the Hammonds plant near Elgin; Doetsch Bros. near Glenview; Material Service Division of General Dynamics Corp. near Half Day; Road Materials Corp. near Arlington Heights; and Worth Sand & Gravel Co., Inc., near Worth produced material for building, paving, and fill. Brisch Brick Co. near Stickney; Carey Brick Co. near Chicago; Chicago Brick Co. near Riverdale; and Illinois Brick Co. near Blue Island produced approximately 316,000 tons of miscellaneous clay for use in manufacturing building brick.

Humus peat was mined near Barrington by Henry Frenzer. Material was sold in bulk for soil conditioning.

Blast and steel furnaces and coke-oven plants were operated in the South Chicago area. Pig iron producers were Interlake Iron Corp.; Republic Steel Corp.; United States Steel Corp.; and Wisconsin Steel Division, International Harvester Co. All except United States Steel Corp. operated coke ovens. Blast furnaces and coke ovens of Youngstown Sheet & Tube Co. remained idle throughout the year. Steel-producing companies included Acme Steel Co., Borg-Warner Corp., Ceco Steel Corp., Columbia Tool Steel Co., A. Finkl & Sons Co., H. M. Harper Co., International Harvester Co., Republic Steel Corp., and United States Steel Corp. United States Steel Corp. announced plans to reclaim nearly 200 acres of submerged land in Lake Michigan to

provide for future expansion of the South Chicago plant. The company also experimented with a continuous casting unit to cut cycle time in steelmaking.

The American Potash & Chemical Corp. manufactured at West Chicago refined thorium compounds from monazite concentrate. The company also produced rare-earth compounds.

Silbrico Corp. produced expanded perlite at its Chicago plant from crude perlite mined in New Mexico. Processed material was used for building plaster, loose fill insulation, concrete aggregate, soil conditioning, filler, and paint texture. Crude vermiculite from Montana and South Carolina was processed by the Zonolite Division, W. R. Grace & Co. at its Chicago plant. Crude mica from South Dakota was ground by U.S. Mica, Inc., and sold for a wide variety of uses.

De Kalb.—Over 291,000 tons of sand and gravel was produced for building, road construction, and fill. Five companies reported production near Cortland, Millington, Sycamore, and Waterman. The county highway department contracted for paving gravel. Crushed limestone for roadstone and agricultural uses was produced by two companies near Cortland and Fairdale. Mica Pellets, Inc., produced exfoliated vermiculite at its DeKalb plant from crude material mined in Montana. The company also produced expanded perlite from crude material mined in New Mexico.

Douglas.—Moffat Coal Co. produced coal from its underground mine near Murdock. Over 64 percent of the output was shipped by railroad. The entire production was cleaned by jigs and about one-third of the total output was thermally dried.

Du Page.—Elmhurst-Chicago Stone Co. produced crushed limestone from its stationary plant near Elmhurst for concrete aggregate, roadstone, and agricultural uses. The company also produced sand and gravel from its stationary plants near Warrenville and Bartlett for building and road purposes.

Edwards.—The Albion Brick Co. was inactive the entire year.

Fayette.—Crushed limestone was produced by Winter's Stone Quarry at its stationary plant near Ramsey for roadstone and agricultural uses. Sand and gravel was produced by three companies operating stationary plants near Hagarstown, Mulberry Grove, and Vandalia for building, road construction, fill, and molding purposes. Diller Shale Products Co. produced miscellaneous clay for use in manufacturing heavy clay products at its St. Elmo plant.

Franklin.—Coal was produced by Freeman Coal Mining Corp. from its Orient No. 5 underground mine and by Old Ben Coal Corp. from its No. 9 and No. 21 underground mines. The Old Ben Coal Corp. No. 21 was the ninth-ranked bituminous coal producer in the Nation. These mines are located near Benton, West Franklin, and Sesser, respectively. Production increased nearly 7 percent to over 5.2 million tons. Output was treated at three plants by heavy media, jigging, and pneumatic methods. Ninety-seven percent of the production was shipped by railroad. Old Ben Coal Corp. was sinking a shaft to the No. 6 coal seam for the No. 24 mine northeast of Benton.

Fulton.—Coal production increased 22 percent to 6.3 million tons. The county ranked first in output from strip mines and second in total production in the State. Coal was cleaned at seven plants. Of

the total production, 69 percent was shipped by railroad, 23 percent by water, and the remainder by truck. An article describing the Delta Coal Corp. Sun Spot mine was published.[4]

Sand and gravel was produced by Duck Island Sand & Gravel Co. near Canton; Brown County Stone Co. near Enion; and Otter Creek Sand & Gravel Co. near Havanna, for building, road construction, fill and other uses. County and State highway departments contracted for paving gravel.

Gallatin.—Total coal production decreased 30 percent from two underground mines near Junction and Sparks Hill. About 78 percent of the total output was shipped by barge. No crushing, treating, or mechanical cleaning was done at the mines.

Sand and gravel was produced by Delta Materials Co. near Shawneetown from a dredging operation. Output was used for building, road construction, and fill. The county highway department produced some material for its own use. The State highway department contracted for paving sand and gravel.

Greene.—Nearly 245,000 tons of crushed limestone was produced by two companies near Hillview and Kane from two quarries and one underground mine. Output was used for roadstone, agricultural purposes, and riprap. American Vitrified Products Co., White Hall, produced plastic fire clay and miscellaneous clay for use in manufacturing vitrified sewer pipe. Eddie Geldner produced plastic fire clay near Roodhouse and sold it for use in manufacturing building brick.

Birch Creek Coal Co. produced coal near Roodhouse for local consumption. Output decreased over 14 percent.

Grundy.—Coal was produced by Peabody Coal Co. from a strip mine near Wilmington that extends into adjacent Kankakee and Will Counties. Output from the Grundy County portion decreased about 15 percent. Production was also reported from the Will County portion. Over 62 percent of the Grundy County production was shipped by truck, the remainder by railroad. The coal was processed in the company's plant in Will County.

Sand and gravel was produced by Material Service Division of General Dynamics Corp. near Morris. Output was used for building and road construction. Illinois Clay Products Co. produced over 100,000 tons of plastic fire clay near Coal City for use in manufacturing refractories.

Hardin.—Shipments of finished fluorspar decreased slightly in quantity but increased over 2 percent in value. Major producing companies were Aluminum Company of America, Minerva Oil Co., and Ozark-Mahoning Co.

Aluminum Company of America operated their Fairview and Blue Diggings mines to produce acid-grade fluorspar, lead and zinc concentrates. Minerva Oil Co. operated its Crystal group and No. 1 mines and mills. The Fairbairn mine of the Crystal group was idle approximately half the year. Fluorspar, lead and zinc concentrates were produced at the Crystal mill, and fluorspar and zinc concentrates at the No. 1 plant. Ozark-Mahoning Co. operated the Mahoning,

[4] Coal Age. Delta Plans and Opens Sun Spot Mine in Illinois No. 2 Seam. V. 68, No. 2, Feb. 1963, pp. 90–96.

Hill-Ledford, and Deardorff mines to produce fluorspar as well as lead and zinc concentrates. Hoeb Mining Co. produced crude ore and sold it to Kentucky Fluorspar Co. for milling. The company closed its mine in August. Other companies sold material from stockpiles for processing in Kentucky. Production from Pope County was processed at mills in the county. A small quantity of crude ore from Kentucky was processed in Hardin County.

Crushed limestone for roadstone and agricultural purposes was produced by Denny & Simpson Stone Co. near Elizabethtown; Rigsby & Barnard Quarry near Cave-in-Rock; and Williams Quarry near Harrisburg. Missouri Portland Cement Co. opened a limestone quarry near Cave-in-Rock to supply their new cement plant near Joppa. Shipments to the plant were by barge on the Ohio River.

Henry.—The Shuler Coal Co. produced coal from an underground mine near Alpha. Production increased 11 percent from 1962. Shipments were mainly by railroad.

Limestone was produced by Cleveland Quarry, Inc., for roadstone. About 62,000 tons of sand and gravel was produced for building, paving, fill, and foundry uses by Collinson Bros., Oberlaender Sand Co., and Schadt Service Co.

Jackson.—Coal production increased 24 percent over that of 1962 to approximately 1.3 million tons. Five companies contributed to the output. Most of the county production was from the Burning Star strip mine, operated by Truax-Traer Coal Division, Consolidation Coal Co., Inc., near Elkville. The entire output from the mine was cleaned at the company plant in Perry County. Farley Bros. Coal Co. produced coal from a strip mine near DeSoto. Elk Coal Co. operated an underground coal mine near Elkville. Belle Rive Mining Co., Inc., and Richerson Coal Co. opened new strip mines near Dowell and Golconda but operated only part of the year. Most of the shipments were by railroad.

Illinois Quarry Co. near Ava produced crushed limestone for roadstone, railroad ballast, and agricultural purposes. Sand and gravel was produced by Lawder Sand Co. from its dredging operation near Grand Tower for building, road construction, and fill.

Jefferson.—Coal was produced by Freeman Coal Mining Corp. from the Orient No. 3 underground mine near Waltonville and by Belle Rive Mining Co., Inc., from its strip mine near Belle Rive. The Orient No. 3 was ranked as eighth largest producer of bituminous coal in the Nation. Output in the county increased nearly 3 percent over that of 1962. Most of the shipments were by railroad.

Randall Stone Co. produced limestone near Mount Vernon for roadstone and agricultural purposes.

Jo Daviess.—Production of lead and zinc decreased about 37 percent. The Eagle-Picher Co. operated the Graham-Snyder-Spillane-Feehan mine and the O'Rourke mine. Ore was concentrated at the Graham mill. The Graham mill also processed ore from the company's Booty-Thompson mine in Lafayette County, Wis. Tri-State Zinc, Inc., closed the Amelia mine in February and the Gray mine in April.

About 399,000 tons of crushed limestone was produced for roadstone, railroad ballast, and agricultural purposes by five companies. Producers included Broege Limestone Co.; Rees Construction Co.; Rein,

Schultz & Dahl, Inc.; Elmer Wienen & Sons Co.; and Willowa Engineering Co. Dubuque Sand & Gravel Co. produced 302,000 tons of sand and gravel near East Dubuque for building, paving, and fill.

Johnson.—Nearly 1 million tons of crushed limestone was produced by Charles Stone Co. near Cypress, Ramona Stone Co. near Goreville, and Southern Illinois Stone Co. near Buncombe. All plants were stationary.

Kane.—Over 3 million tons of sand and gravel was produced by 11 companies using portable and stationary plants near Algonquin, Big Rock, East Dundee, Elburn, Elgin, Hampshire, Montgomery, North Aurora, and St. Charles. The material was used for building, paving, fill and other purposes. Conco-Western Stone Co.; Fox River Stone Co.; and Rein, Schultz & Dahl, Inc., produced 287,000 tons of limestone near North Aurora and Elgin for roadstone, agricultural use, rubble, architectural stone, and flagging.

Batavia Soil Builders produced reed-sedge peat near Batavia for soil conditioning. Material was sold in bulk form.

Natural red iron oxide pigments were produced by George B. Smith Chemical Works, Inc., at its plant at Maple Park from crude iron oxide produced in Michigan.

Kankakee.—Crushed limestone was produced by Lehigh Stone Co. near Kankakee and Manteno Limestone Co. near Manteno for roadstone, railroad ballast, and agricultural purposes. Clay was produced for heavy clay products by Eastern Illinois Clay Co. and St. Anne Brick & Tile Co. near St. Anne, and Kankakee Clay Products Co. near Kankakee.

Peabody Coal Co. did not produce from the Kankakee County portion of their Northern Illinois coal mine.

Perlite was expanded for use as acoustical aggregate by U.S. Perlite Corp. at its Momence plant from crude material mined in New Mexico.

Sand and gravel was produced by the Kankakee Bank Sand Co. near Kankakee for use as railroad ballast. The State highway department contracted for paving sand.

Knox.—Coal was produced by Midland Electric Coal Corp. from the Middle Grove strip mine near Farmington and the Mecco strip mine near Victoria. Coal from the Middle Grove mine was processed at the company plant in Fulton County. Output from the Mecco mine was processed at the company plant near Atkinson in Henry County. The Mecco mine is the former Victoria No. 5 mine of Midland Collieries, Inc. Virtually all shipments were by rail.

Abingdon Rock Co. produced limestone near Abingdon for roadstone and agricultural purposes. Knox County Gravel Co. operated a portable plant near Princeville and produced 15,000 tons of paving gravel. The State highway department contracted for paving sand. Alton Brick Co. produced miscellaneous clay near East Galesburg for manufacturing building brick. Briggs Manufacturing Co. produced ground feldspar at its Abingdon plant from crude material mined by the company in South Dakota for use in manufacturing pottery.

Lake.—Over 1 million tons of sand and gravel was produced by 7 companies operating stationary and portable plants near Antioch, Barrington, Gurnee, Half Day, Libertyville, Spring Grove, Wads-

worth, and Wauconda. Output was for building, paving, fill, and other purposes. The State and county highway departments contracted for an additional 144,000 tons of paving sand and gravel. Total county production decreased 38 percent from that of 1962. Clay was produced by National Brick Co. near Deerfield. Total output of 42,000 tons was used in manufacturing building brick. National Gypsum Co. manufactured gypsum products at its Waukegan plant from crude material mined by the company in Michigan.

General Motors Corp. produced coke at its Waukegan plant for foundry use.

La Salle.—The county retained its rank of first in value of mineral output (excluding liquid fuels and natural gas) in the State. Alpha Portland Cement Co. near LaSalle as well as Lehigh Portland Cement Co. and Marquette Cement Manufacturing Co. near Oglesby produced portland and masonry cements. Each company quarried limestone for use in manufacturing cement. Shipments of cement went mainly to consumers in Illinois, Indiana, and Wisconsin. Lehigh Portland Cement Co. closed its Oglesby plant late in the year. Crushed limestone was produced for roadstone and agricultural purposes by Beardsley Stone Co. near Sheridan, Troy Grove Stone Co. near Troy Grove, and Utica Stone Co. near Utica.

Over 3.5 million tons of sand and gravel was produced by 13 companies at 17 operations. Total production decreased approximately 11 percent from that of 1962 mainly because of reduced use in road construction. Output was for building and road construction, fill, railroad ballast, glass manufacture, molding, grinding, polishing, sand blasting, engine use, filtration, oilfield fracturing, cement manufacture, abrasives, chemical, enamel, filler, foundry, and pottery purposes. Producers of silica sand included American Silica Sand Co., Inc., near Utica; Arrowhead Silica Corp. near Troy Grove; Bellrose Silica Co., Ottawa; Ottawa Silica Co. Ottawa; and Wedron Silica Co. near Wedron. Pure Silica Co., formerly Blackhawk Silica Sand Co., continued construction on its silica sand plant near Troy Grove. The State, LaSalle County, and DeKalk County highway departments contracted for paving sand and gravel.

Rein, Schultz & Dahl, Inc., did not operate in the county during 1963.

Alpha Portland Cement Co. and Marquette Cement Manufacturing Co. produced miscellaneous clay for use in manufacturing cement. Material Service Division of General Dynamics Corp. produced shale for use in manufacturing lightweight aggregate near Ottawa. Hydraulic Press Brick Co. near Utica and Ristokrat Clay Products Co. (formerly Conco-Meier Co.) near Tonica mined clay for use in manufacturing building brick. Illinois Valley Minerals Corp. produced fire clay near Ottawa and sold it for use in manufacturing refractory products.

The Matthiessen & Hegeler zinc smelter at LaSalle was inactive throughout the year.

Lee.—Medusa Portland Cement Co. produced portland and masonry cements at its Dixon plant. Limestone and clays were mined by the company for use in manufacturing cement. Crushed limestone was also produced by Frank N. Butler Co., Oregon Stone Quarries, Laurde Renner Limestone Co., Stoneridge Limestone Co., and Wastone, Inc.

Plants were operated near Ashton, Dixon, Lee Center, and Steward. Material was used for road construction and agricultural purposes. Sand and gravel production decreased 4 percent to about 231,000 tons. Output was used for building, road construction, and fill. Producing companies included C. C. Macklin near Steward, Nelson Sand & Gravel Co. near Nelson, and Rock River Ready Mix, Inc., near Dixon. The State highway department contracted for paving sand and gravel.

Livingston.—Crushed limestone was produced near Chenoa and Pontiac by Chenoa Stone Co., Livingston Stone Co., Ocoya Stone Co., Pontiac Stone Co., and Wagner Stone Co. Output of nearly 1.3 million tons was used for road construction, agriculture, riprap, asphalt filler, and other purposes. Miscellaneous clay was produced by Diller Tile Co., Inc., near Chatsworth and Hydraulic Press Brick Co. and Streator Clay Pipe Co. near Streator for use in manufacturing building brick, vitrified sewer pipe, and other heavy clay products. Howard Arnold Construction Co., Rowe Construction Co., and Valley View Dirt & Gravel Co. produced sand and gravel for road construction and fill.

Logan.—About 20,000 tons of coal was mined by Logan County Coal Mine, Inc. (formerly McSpadden Bros.) from an underground mine near Lincoln. Output was cleaned by pneumatic methods and sold for local consumption. Most shipments were by truck.

Crushed limestone for road construction and agriculture was produced by Rocky Ford Limestone Co. near Lincoln. Allsopp's Sand & Gravel; R. A. Cullinan & Son, Inc.; and Lincoln Sand & Gravel Co. produced sand and gravel for building, road construction, and fill. Plants were operated near Fort Pulaski, Atlanta, and Lincoln, respectively. The State highway department contracted for paving gravel.

McDonough.—Plastic fire clay, stoneware clay, and miscellaneous clay were produced near Colchester by Booz & Co.; Ceramics, Inc.; Colchester Brick & Tile Co.; and Martin's Clay Pits. Material was used in manufacturing building brick, vitrified sewer pipe, drain tile, refractory products, and artware. Crushed limestone was produced near Colchester by Colchester Stone Co. and McClure Quarries, Inc., for riprap, road construction, and agricultural purposes. The State highway department contracted for paving sand.

McHenry.—Approximately 3.9 million tons of sand and gravel was produced by 12 companies and the county highway department. Output was for building and road construction, railroad ballast, fill, and other uses. Portable and stationary plants were operated near Alden, Algonquin, Cary, Crystal Lake, Island Lake, Marengo, McHenry, and Woodstock. The State highway department contracted for paving gravel. The Consumers Co. Algonquin plant was closed in 1963. Peters Sand & Gravel Co. discontinued operations at its fixed plant near Harvard. Garden Prairie Stone Co., Inc., operated a portable plant near Marengo and produced limestone for roadstone, agricultural use, and flagging. The company also produced paving gravel.

Macoupin.—About 287,000 tons of coal was produced by Little Dog Coal Co. from an underground mine near Gillespie. The entire output was mechanically cleaned. About 83 percent of the total production was shipped by rail; nearly all the remainder by truck.

Exfoliated vermiculite was produced by International Vermiculite Co. at Girard from crude material mined in Montana. Sales were for insulating purposes.

Madison.—A total of 580,000 tons of coal was produced from two underground mines operated by Livingston-Mt. Olive Coal Co. near Livingston and Lumaghi Coal Co. near Collinsville. Both companies operated cleaning plants; Livingston-Mt. Olive Coal Co. used the heavy-media method and Lumaghi Coal Co. used jigs. About 94 percent of the total shipments were by truck; most of the remainder was by rail.

C. M. Lohr, Inc., Reliance Whiting Co., and Mississippi Lime Co. produced limestone near Alton and Godfrey. Mississippi Lime Co. operated an underground mine; the others operated open quarries. Output was for concrete aggregate and roadstone, agricultural limestone, riprap, and other uses. Sand and gravel was produced near Alton and Granite City for building, road construction, engine use, fill and other purposes. The State highway department contracted for paving sand.

Coke ovens and blast and steel furnaces were operated at Granite City by the Granite City Steel Co. La Clede Steel Co. produced steel in open-hearth furnaces at Alton.

The Anlin Company of Illinois recovered sulfur by the Amine Gas Purification and Modified Claus processes from refinery gases at Wood River.

Marion.—Shoots Stone Quarry operated a portable plant near Iuka and produced crushed limestone for roadstone and agricultural uses.

Marion County Coal Mining Corp. produced about 6,000 tons of coal from an underground mine near Centralia. Output decreased substantially from 1962.

Marshall.—About 238,000 tons of paving sand and gravel was produced. Three companies operated portable plants near Lacon and La Rose. Princeville Stone Co. sold material only from stockpile. Hydraulic Press Brick Co. produced clay near Sparland and used the material for manufacturing building brick.

Massac.—Missouri Portland Cement Co. completed construction of its new dry-process cement plant near Joppa and began production in midyear. The plant has an annual capacity of 3 million barrels. Major equipment included a 550-foot coal-fired kiln, with designed capacity of 8,500 barrels per day. Limestone for the plant was quarried and crushed near Cave-in-Rock, in Hardin County, and barged on the Ohio River to the Joppa plant.

Illinois Clay Products Co. produced 2,000 tons of fire clay near Metropolis for use in foundries and steelworks. The company's Betz plant was closed May 1. Columbia Quarry Co. produced limestone for road construction and agricultural uses from its Mermet No. 10 quarry near Karnak. The State highway department contracted for paving sand and gravel.

Menard.—Athens Stone Quarry and D–P Indian Point Limestone Products, Inc., produced crushed limestone near Athens chiefly for road construction and agricultural uses. Petersburg Clay Products Co., Inc., produced clay near Petersburg and used the material for manufacturing building brick.

New Salem Coal Co., Inc., operated an underground coal mine near Petersburg. Production of about 3,200 tons was less than half that of 1962. The entire output was for local consumption.

Mercer.—Approximately 63,000 tons of coal was produced in the county, about 8 percent below 1962 production. Producing companies were Hazel Dell Coal Corp., operating an underground mine near New Windsor, and Viola Materials, Inc., operating a strip mine near Viola. About three-fourths of the total output was shipped by rail; the remainder by truck.

Mercer County Stone & Coal Co. and Viola Materials, Inc., quarried limestone near Viola chiefly for road construction. Hydraulic Press Brick Co. mined clay near Aledo for use in manufacturing building brick. The State highway department contracted for paving sand and gravel.

Monroe.—Columbia Quarry Co. produced crushed limestone from its Valmeyer No. 3 quarry near Valmeyer. The material was for road construction, agricultural limestone, flux and other metallurgical uses, asphalt filler, fertilizer filler, fire-inhibiting dust for coal mines, and mineral in stock feed.

Montgomery.—Over 2 million tons of coal was produced from the Crown underground mine, operated by Freeman Coal Mining Corp. near Farmersville. The entire output was cleaned by jigging and pneumatic methods. Truax-Traer Coal Division, Consolidation Coal Co., Inc., began sinking two mine shafts to provide coal for a mine-mouth electric power complex near Hillsboro. The project was expected to be completed in 1965.

Four companies produced a total of 610,000 tons of crushed limestone from quarries near Litchfield and Nokomis. Output was for road construction, agricultural limestone, and riprap. Additional screens and a pulverizing mill were installed at the plant of Central Illinois Stone Co., Inc., near Nokomis. Fournier Stone Co. acquired the quarry formerly operated by Chuck Johnson. The company name of Nokomis Lime Quarry was changed to Nokomis Quarry, Inc.

Ogle.—About 692,000 tons of sand and gravel for building, road construction, railroad ballast, glass, molding, fill, and other uses was produced from plants near Byron, Forreston, Kings, and Oregon. Commercial operators were Byron Material Service, McGrath Sand & Gravel Co., C. C. Macklin, Manley Sand Division of Martin Marietta Corp., and Floyd Weigle. C. C. Macklin did not operate its plant in 1963 but shipped from stockpiles. The Leaf River Township and county highway departments also produced paving gravel. Over 448,000 tons of crushed limestone, a decrease of 5 percent from 1962, was produced by seven companies and the county highway department. Output was for road construction and agricultural limestone. Quarries were operated near Byron, Leaf River, Oregon, Polo, and Rochelle. Producers were Byron Material Service, Kutz Bros. Co., McGrath Sand & Gravel Co., Macklin Bros., Oregon Stone Quarries, Pine Creek Rock Co., and Rochelle Stone, Inc.

Peoria.—Approximately 943,000 tons of coal was produced, an 11-percent decrease compared with 1962. Output was from five strip mines and two underground mines. Producers were Layne's Coal Co., Peabody Coal Co., Sherwood-Templeton Coal Co., Inc., The

United Electric Coal Cos., Big Bear Coal Co., and Zaborac Coal Co. On August 1, Peabody Coal Co. acquired the Edwards strip mine, formerly operated by Morgan Coal Co. The underground mine of Lightbody Coal Co. near Glasford was closed January 1. Gibson Coal Co. produced no coal in the county in 1963. Ninety-six percent of the county coal production was mechanically cleaned at three plants.

Six companies produced a total of 1.5 million tons of sand and gravel for building, road construction, railroad ballast, fill, and other uses. Plants were operated near Chillicothe, Kickapoo, and Peoria. About 491,000 tons of crushed limestone was produced by three companies near Princeville. The material was used for road construction and agricultural limestone. Missouri Portland Cement Co. constructed a new cement distribution center near Peoria.

Perry.—Over 3.5 million tons of coal was produced, a 5-percent increase over 1962. Output was from three strip mines operated by Southwestern Illinois Coal Corp., Truax-Traer Coal Division, Consolidation Coal Co., Inc., and The United Electric Coal Cos. as well as from an underground mine operated by New Cutler Coal Co. The mine of Southwestern Illinois Coal Corp. extended into Randolph County. Cleaning plants in the county were operated by Truax-Traer Coal Division and The United Electric Coal Cos. The Truax-Traer plant also processed coal mined by the company in Jackson County.

Pike.—About 400,000 tons of crushed limestone was produced, chiefly for roadstone and agricultural limestone. Producers were V. H. Callender Construction Co., Lacey & Bauer Quarry, Lumley Quarry Co., Missouri Gravel Co., and Webster Limestone Co. Quarries were operated near Pearl, Pittsfield, and Pleasant Hill. Missouri Gravel Co. also operated a stationary sand and gravel plant near Barry and produced material for paving use and railroad ballast. The State highway department contracted for paving gravel.

Pope.—Ozark-Mahoning Co. mined fluorspar ore from its Parkinson and Loyd-Gibson properties. The crude material was processed at the company plant in Hardin County. The company completed repayment of $11,120 under an Office of Minerals Exploration (formerly Defense Minerals Exploration Administration) assistance contract made in 1954 covering fluorspar exploration in Pope County. Exploratory work was completed in December, 1954, and a discovery was certified in April, 1955. Royalties paid on production during 1962 and 1963 have completed repayment. A small quantity of fluorspar ore was sold by other producers and processed at a plant in Kentucky.

The county highway department produced nearly 7,000 tons of paving gravel. The State highway department contracted for 2,000 tons of paving gravel.

Pulaski.—Columbia Quarry Co. produced limestone from its No. 8 quarry near Ullin. The material was used for roadstone, railroad ballast, agricultural limestone, and riprap. Star Enterprises, Inc., produced clay near Olmsted and sold the material for absorbent uses. Sand and gravel production declined substantially from 1962. Delta Materials Co. produced 10,000 tons of paving sand near Olmsted. The county highway department produced 5,000 tons of paving gravel. Mize Gravel Pit reported no use of material from its pit in 1963.

Randolph.—Nearly 1.9 million tons of coal was produced from two

strip mines, operated by Eden Mining Co. and Southwestern Illinois Coal Corp. near Sparta and Percy, respectively, and an underground mine, operated by Ziegler Coal & Coke Co. near Sparta. The latter two companies operated cleaning plants utilizing jigs. Southwestern Illinois Coal Corp. also produced some coal from the Perry County portion of its Streamline mine. Midland Electric Coal Corp. announced plans for opening a new strip mine near Percy to supply 40 million tons of coal to the Joliet plant of Commonwealth Edison Co. over the next 10 years. The new Captain mine was to be operated by Southwestern Illinois Coal Corp. in conjunction with the latter's Streamline mine. Production from the new mine was expected to begin late in 1964. In June, Eden Mining Co. purchased the mine formerly operated by Ritter Coal Co.

Allied Chemical Corp., Chester Quarry Co., and Stotz Quarry Co. operated underground limestone mines near Chester and Prairie du Rocher. Output was for roadstone, agricultural limestone, and chemical uses. Sand for building, road construction, and engine use was produced by Southern Illinois Sand Co. at a dredging operation near Chester. The State highway department contracted for paving sand.

Rock Island.—Allied Stone Co., Collinson Stone Co., Cordova Quarry Inc., and Midway Stone Co., Inc., produced a total of 1.1 million tons of limestone. Quarries were operated near Cordova, Hillsdale, and Milan. Output was for roadstone, agricultural use, and riprap. About 594,000 tons of sand and gravel was produced, a 15-percent decrease from that of 1962. Output was for building, road construction, and foundry uses. Builders Sand & Gravel Co. and Moline Consumers Co. operated dredges near Albany and Cordova, respectively. Other producers were General Sand & Gravel Co. (near Milan), Kouski & Stout (near Coal Valley), and Oberlaender Sand Co. The State highway department contracted for paving sand. The Flintkote Co. produced plastic fire clay near Carbon Cliff and used the material for manufacturing chimney liners.

St. Clair.—St. Clair County ranked third in State coal production, with output of 5.7 million tons, a 20-percent increase over that of 1962. About 79 percent of the production was from three strip mines; the remainder was from four underground mines. Two strip mines were operated near Millstadt by Morgan Coal Co. and by Peabody Coal Co., which also operated the River King strip mine near Freeburg, in 1963, the largest producing strip mine and the third largest producing bituminous coal mine in the United States. Operating underground mines were Midland Electric Coal Corp. (near Marissa), Peabody Coal Co. (near Millstadt), and Belle Valley Coal Co., Inc., and Shiloh Valley Coal Co. (near Belleville). Virtually the entire county coal output was cleaned at six preparation plants.

Limestone production decreased 17 percent to less than 1.8 million tons. Output was for concrete aggregate, roadstone, agricultural limestone, railroad ballast, riprap, and other uses. Columbia Quarry Co. operated quarries near Columbia and Dupo. Other limestone producers were East St. Louis Stone Co., Quality Stone Co., Inc., and The Casper Stolle Quarry & Contracting Co., operating quarries near East St. Louis, Hecker, and Dupo, respectively. Missouri-Illinois Material Co. produced sand near East St. Louis for building, road

construction, fill, and engine use. Hydraulic Press Brick Co. produced clay near East St. Louis and used the material for manufacturing lightweight aggregate. Hill Brick Co. mined clay near Belleville for use in manufacturing building brick.

American Zinc Co. of Illinois operated an electrolytic zinc refinery at Monsanto and a roasting plant at Fairmont City.

C. K. Williams & Co. produced ground barite at East St. Louis for paint filler, rubber filler, and pharmaceutical purposes. Crude barite processed was mined in Missouri. The company also produced a wide variety of finished pigments from iron ore and pyrite cinders produced outside the State.

Saline.—About 3.8 million tons of coal was produced, a 9-percent increase compared with 1962. Production was from ten strip mines (furnishing 61 percent of the total) and two underground mines. Sahara Coal Co., Inc., operated the two underground mines, the Nos. 5 and 16, as well as a strip mine, all near Harrisburg. Other producers were Herod Mining Corp., Houston Coal Co., J. W. Coal Co., Inc., Liberty Coal Co., Marshall Equipment Co., New Oak Hill Coal Co., Walse Coal Co., and Youngs Coal Corp. (formerly Saxton Coal Corp.). Two cleaning plants were operated. Approximately 84 percent of the county production was shipped to consumers by rail and 13 percent by barge. The remainder was for local consumption.

Sangamon.—Sand and gravel production increased 15 percent to 680,000 tons. Output was for building, road construction, fill, and other uses. Buckhart Sand & Gravel Co., Inc., produced from six pits in the county. Clear Lake Sand & Gravel Co. and Springfield Sand & Gravel Co. operated dredges near Springfield.

Over 97,000 tons of coal was produced, a 19-percent increase compared with 1962. Production was from two underground mines, operated near Cantrall by Eddy Coal Co. and R&S Coal Mine, Inc.

Poston Brick & Concrete Products Co. produced clay near Springfield and used the material for manufacturing building brick and lightweight aggregate. Clay Products Co. mined clay near Springfield for use in manufacturing heavy clay products.

Tamms Industries Co. produced iron oxide pigments at its Springfield plant from Michigan iron ore.

Schuyler.—Peabody Coal Co. produced 591,000 tons of coal from the Key strip mine near Rushville. The entire output was cleaned by jigging. About 84 percent of the total production was shipped by barge on the Illinois River; the remainder by rail and truck.

Elas Quarries operated a portable plant near Rushville and produced about 21,000 tons of crushed limestone for roadstone and 17,000 tons of sand and gravel for paving use and fill. The Brown County Stone Co. produced no material in 1963. The county highway department produced 1,000 tons of paving gravel, and the State highway department contracted for nearly 1,000 tons of gravel for use on highways.

Scott.—Krueger Quarry and Thomas Quarry, Inc., produced crushed limestone near Winchester. The material was used for roadstone and agricultural limestone. Sterling Shafer produced clay near Alsey and sold the material for use in manufacturing building brick.

Stark.—Stonefort Coal Mining Co., Inc., produced about 537,000 tons

of coal from its Allendale strip mine near Wyoming. Output increased 10 percent over that of 1962. The entire production was cleaned by jigging. All shipments to consumers were by rail.

R. A. Cullinan & Son, Inc., operated a portable plant near Castleton and produced paving gravel. Howard H. Harmon produced 11,000 tons of gravel from a pit near Wyoming, but discontinued business November 1.

Tazewell.—Approximately 1.2 million tons of sand and gravel was produced, a 19-percent decrease compared with 1962. Commercial producers included R. A. Cullinan & Son, Inc., Hoffer Construction Co., Inc., McGrath Sand & Gravel Co., and C. A. Powley Co. Plants were operated near East Peoria, Green Valley, Hopedale, Mackinaw, Manito, Pekin, and Tremont. Output was for building, road construction, railroad ballast, fill, and other purposes. The county highway department contracted for paving gravel. Peoria Brick & Tile Co., produced clay near East Peoria for use in manufacturing building brick.

Union.—Anna Quarries, Inc., Jonesboro Stone Co., and Midwest Stone Co., produced a total of 848,000 tons of crushed limestone from quarries near Anna. Output, representing a 21-percent increase over that of 1962, was for concrete aggregate and roadstone, agricultural limestone, and asphalt filler. Lutz Marble Co., Inc., produced dimension limestone near Anna for house stone veneer. Bittle Construction Co., operated a portable plant near Anna and produced 6,000 tons of paving gravel.

Vermilion.—Coal was produced from three strip and three underground mines, all near Danville. Total production was about 1.2 million tons, 5 percent more than in 1962. Strip mines furnished 96 percent of the total. Strip-mine operators were Fairview Collieries Corp., The United Electric Coal Cos., and Two Rivers Coal Co. Underground mines were operated by Blue Lake Coal Co., Inc., Deep Valley Coal Co., and V-Day Coal Co. Cleaning plants were operated by Fairview Collieries Corp. and V-Day Coal Co.

Material Service Division of General Dynamics Corp. produced limestone from its Fairmount quarry. Output was for concrete aggregate and roadstone and agricultural limestone. Eight companies produced a total of 106,000 tons of sand and gravel. Output was for building, road construction, and fill. Stationary and portable plants were operated near Alvin, Danville, Fithian, Oakwood, Rossville, and Westville. Allison Gravel Pit discontinued business in 1963. Western Brick Co., Division of Illinois Brick Co., mined clay near Danville and used the material for manufacturing building brick and lightweight aggregate.

Wabash.—Sand and gravel production decreased 15 percent to 191,000 tons. Output was for building, road construction, railroad ballast, fill, and other purposes. Plants were operated near Allendale, Bellmont, and Mount Carmel. The Trusty Sand & Gravel Co. discontinued business in 1963. The State highway department contracted for paving sand and gravel.

Allendale Coal Co. produced 3,000 tons of coal from a strip mine near Allendale. The entire output was for local consumption.

Washington.—Pitts Quarry, Inc., produced 86,000 tons of crushed

limestone near Radom for roadstone and agricultural limestone. Venedy Coal Co., Inc., produced 23,000 tons of coal from an underground mine near Venedy. Output, mostly for local consumption, decreased 5 percent.

Will.—Nearly 2.6 million tons of sand and gravel was produced for building, road construction, railroad ballast, and fill. Output increased 12 percent. Producers were Avery Gravel Co., Chicago Gravel Co., Elmhurst-Chicago Stone Co., Material Service Division of General Dynamics Corp., C. H. Monk, and H. Turner & Son. Plants were operated near Channahon, Joliet, Lemont, Lisle, Lockport, and Plainfield. The State highway department contracted for paving sand. Limestone production dropped markedly to 1,750,000 tons. Output was for concrete aggregate and roadstone, agricultural limestone, railroad ballast, blast-furnace flux, and other metallurgical uses. Producers were Lincoln Stone Co.; Material Service Division of General Dynamics Corp.; National Stone Co., Division of Dolese & Shepard Co.; and the Illinois State Penitentiary. Quarries were operated near Joliet and Lockport. Lincoln Stone Co. erected a new plant to replace one destroyed by a fire in February.

Over 335,000 tons of coal was produced from the Will County portion of the Northern Illinois strip mine, operated by Peabody Coal Co. near Wilmington. Production also was recorded for the portion of the mine extending into Grundy County. The entire production was cleaned by jigging.

The Pure Oil Co. recovered elemental sulfur from gases at its refinery near Lemont, utilizing the Modified Claus process. The Celite Division of Johns-Manville Perlite Corp. produced expanded perlite at Joliet from crude material mined outside the State. The expanded product was used chiefly for insulating material and filter purposes. Lehigh Portland Cement Co. constructed a bulk cement distribution terminal near Plainfield.

Williamson.—Williamson County ranked first in coal production with an output of 6.4 million tons, or 11 percent greater than that of 1962. Ten underground mines furnished 57 percent of the total; the remainder was from six strip mines. Total production from underground mines decreased 3 percent whereas strip mine production increased 37 percent. Major producers included Bell & Zoller Coal Co., Crab Orchard Co-op Coal Co., Forsyth-Energy Co., Freeman Coal Mining Corp., Peabody Coal Co., Stonefort Coal Mining Co., Inc., and Thunderbird Collieries Corp. (formerly Carmac Coal Co.). Nearly 5.9 million tons was cleaned at 12 plants. Over 94 percent of the county output was shipped by rail. On August 1, Peabody Coal Co. acquired the Utility strip mine, formerly operated by Utility Coal Co. In August, Blue Bird Coal Co. acquired the underground mine formerly operated by Norman Coal Co. near Harrisburg. The strip mine of Big Three Coal Co. near Marion was inactive in 1963.

The State highway department contracted for paving sand and gravel.

Winnebago.—Over 1.3 million tons of sand and gravel was produced, a 19-percent decrease from 1962 output. The material was for building, road construction, fill, and other uses. Commercial producers were Illinois-Wisconsin Sand & Gravel Co., John L. Kelley & Sons,

Larson Bros. Sand & Gravel, Northwest Gravel Co., Porter Bros., Rockford Sand & Gravel Co., and Sahlstrom Building Products, Inc. Plants were operated in the Rockford-South Beloit area. The State and county highway departments contracted for gravel for road use and fill, respectively. The Northwest Gravel Co. was liquidated at the close of the year. A total of 801,000 tons of limestone was produced for concrete aggregate and roadstone, agricultural limestone, and riprap. Producers included E. B. Davis Co., Gregory-Anderson Co., Chas. Ind Co., Porter Bros., F. M. Porter & Sons, Rockford Blacktop Construction Co., Rockford Crushed Rock Co., Fred Smith, Wilson & Shipler, Inc., Arthur Zimmerman & Son, and the county highway department. Quarries were operated near Durand, Pecatonica, Rockford, Rockton, Roscoe, and South Beloit.

The Mineral Industry of Indiana

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey, Indiana Department of Conservation, for collecting information on all minerals except fuels.

By Donald F. Klyce [1] and Mary B. Fox [2]

MINERAL production of Indiana was valued at nearly $203 million, about the same as the 1962 value. Declines in the output of coal and petroleum were offset by an increase in shipments of nonmetallic minerals. The latter group increased nearly 4 percent in value.

Nonmetals accounted for 55 percent of the value of the State mineral production, compared with 53 percent in 1962. As no metallic minerals were produced, the remaining 45 percent represented the value of mineral fuels.

TABLE 1.—Mineral production in Indiana [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasives (whetstones)—short tons	5	$15	5	$16
Cement, portland—thousand 376-pound barrels	12,878	42,572	13,165	43,216
Clays—thousand short tons	1,450	2,255	1,546	2,347
Coal (bituminous)—do	15,709	60,079	15,100	57,120
Natural gas—million cubic feet	284	60	286	67
Peat—short tons	[2] 47,430	272	47,695	412
Petroleum (crude)—thousand 42-gallon barrels	12,077	35,989	[3] 11,417	[3] 33,794
Sand and gravel—thousand short tons	21,261	18,692	22,840	20,683
Stone—do	18,709	34,653	19,667	35,616
Value of items that cannot be disclosed: Masonry cement, gem stones (1962), and gypsum		8,839		9,259
Total		[2] 203,426		202,530

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Revised figure.
[3] Preliminary figure.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

[1] Industry economist, Bureau of Mines, Minneapolis, Minn.
[2] Mineral statistician, Geological Survey, Indiana Department of Conservation, Bloomington, Ind.

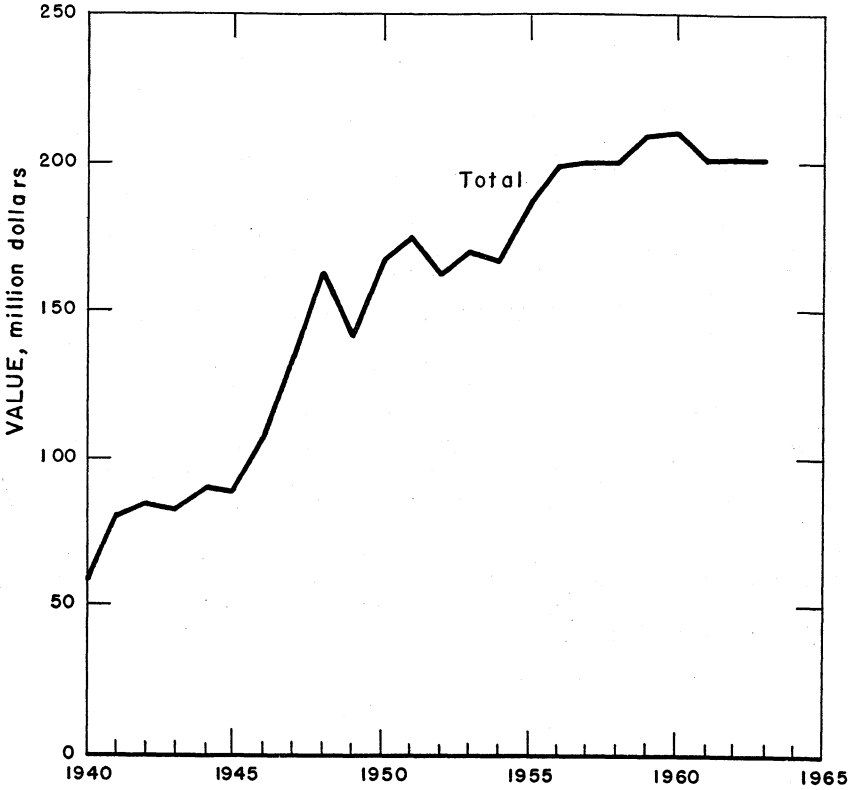


FIGURE 1.—Total value of mineral production in Indiana 1940–63.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$175,484	1958	$201,675
1953	177,176	1959	209,005
1954	176,918	1960	213,431
1955	191,872	1961	205,678
1956	201,136	1962	209,023
1957	199,384	1963	207,681

Employment and Injuries.—Over 21.1 million man-hours were worked in Indiana mineral industries in 1963, excluding employees in the petroleum industry and officeworkers. This represented a 3-percent decrease from the 21.8 million man-hours recorded for 1962. Employment declines in the cement, clay, coal, limestone, and sandstone industries were chiefly responsible for the decrease.

Three fatalities, two at coal mines and one at a cement plant, occurred in 1963, compared with 13 in 1962. The total number of nonfatal disabling injuries increased to 525, (preliminary figure), compared with the final figure of 513 for 1962.

Table 3 contains a summary of employment and injury data for selected State mineral industries. Certain industries are excluded from the table, primarily to avoid disclosing individual company confidential data.

TABLE 3.—Employment and injuries for selected mineral industries [1]

Year and industry	Average number of men working	Total man-hours	Total number of disabling injuries		Total number of days lost or charged	Injury frequency rate [2]	Injury severity rate [3]
			Fatal	Nonfatal			
1962:							
Cement [4]	1,122	2,695,982	1	8	6,814	3.34	2,527
Clays [5]	1,394	1,590,434		43	1,175	27.04	739
Coal (bituminous)	3,104	5,466,756	6	270	53,818	50.49	9,845
Coke ovens	1,331	3,874,545	2	6	(6)	2.06	(6)
Limestone [7]	2,366	4,669,849	2	133	19,322	28.91	4,138
Marl	26	18,632					
Sand and gravel	1,093	2,150,300	2	39	13,321	19.07	6,195
Sandstone	98	148,781		5	85	33.61	571
1963: [8]							
Cement [4]	1,125	2,589,609	1	6	(6)	2.70	(6)
Clays [5]	527	1,050,979		31	(6)	29.50	(6)
Coal (bituminous)	3,000	5,100,000	2	250	(6)	49.41	(6)
Coke ovens	1,364	3,983,969		11	(6)	2.76	(6)
Limestone [7]	2,263	4,432,081		173	(6)	39.03	(6)
Marl	24	20,756					
Sand and gravel	1,052	2,234,610		46	(6)	20.59	(6)
Sandstone	96	134,143		3	(6)	22.36	(6)

[1] Excludes officeworkers.
[2] Total number of injuries per million man-hours.
[3] Total number of days lost or charged per million man-hours.
[4] Includes cement plants and quarries or pits producing raw material used in manufacturing cement.
[5] Excludes pits producing clay used in manufacturing cement.
[6] Data not available.
[7] Excludes quarries producing limestone used in manufacturing cement.
[8] Preliminary data.

Water.—To obtain valid data concerning water use by the mineral industries for 1962, the Bureau of Mines conducted a nationwide canvass of virtually all mineral extractive and certain mineral processing industries. Cement plants and other manufacturing type operations were excluded. Table 4 summarizes some of the data collected for the State. As used in the table, "new water" is that entering the plant as makeup water and when added to the "recirculated water" gives the total used or required for processing. "Water discharged" is used water leaving the plant. "Water consumed" is that which leaves the plant as moisture combined or entrained in the product or lost by evaporation and no longer available for reuse in the vicinity of the plant.

In addition to water use in extracting and processing mineral commodities as indicated in table 4, a substantial amount of water was required by the petroleum industry for well drilling. In 1962, 678,000 42-gallon barrels of water were required for well drilling in Indiana. Approximately 27 gallons of water were required per foot of well drilled.

TABLE 4.—Water statistics for selected mineral industries in 1962, and total

(Million gallons)

Industry	New water	Water recirculated	Total water used	Water discharged	Water consumed
Coal (bituminous)	1,190	8,685	9,875	1,048	142
Sand and gravel	3,964	8,246	12,210	3,754	210
Stone	3,765	875	4,639	3,687	78
Petroleum drilling and secondary recovery	593	462	1,055	52	541
Total	9,512	18,268	27,779	8,541	971

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Materials.—Whetstones were fabricated from sandstone quarried and milled near Orleans in Orange County by Hindostan Whetstone Co. of Bedford. Shipments were about the same as in 1962.

Cement.—Portland and masonry cements were manufactured at plants in Lake County by Universal Atlas Cement Division of United States Steel Corp., at Mitchell in Lawrence County by Lehigh Portland Cement Co., at Limedale in Putnam County by Lone Star Cement Corp., and in Clark and Cass Counties by Louisville Cement Co.

The average mill values of both portland and masonry cements continued to decrease from $3.31 per barrel for portland in 1962 to $3.28, and for masonry from $2.66 to $2.64. However, total shipments of both types were greater than in 1962 by more than 400,000 barrels. Yearend stocks of portland cement were about 1.7 million barrels, compared to 2 million barrels in the previous year. Nearly two-thirds of the portland cement shipments went to ready-mixed-concrete companies, while the remainder was sold to contractors, concrete product manufacturers, and building material dealers.

About 42 percent of the cement shipped was used in Indiana. Principal out-of-State consumers were in Illinois, Kentucky, and Wisconsin. Shipments also went to 11 other States. More than 2.8 million tons of limestone and nearly 1 million tons of clay, shale, slag, sand, gypsum, grinding aids, and air-entraining compounds were used in manufacturing cement. Approximately 321 million kilowatt-hours of electrical energy was used at the plants. Three plants used the dry process of manufacture and two used the wet process. Annual finished-cement capacity of Indiana plants was 20.1 million barrels.

Clays.—Fire clay was mined in 7 counties and used in the manufacturing of pottery, floor and wall tile, refractories, heavy clay products, and a few miscellaneous items (terra cotta, stoneware, etc.). Quantity and value of fire clay increased 29 percent and 27 percent respectively, compared with 1962. Much of the increase was due to larger requirements of manufacturers of heavy clay products.

Miscellaneous clay was mined in 18 counties. Principal consumers were manufacturers of cement, lightweight aggregates, and heavy clay products (building brick, pipe, tile, etc.). Output was about the same as in 1962.

Figures compiled by the Indiana Geological Survey indicated that the value of products manufactured from clay and shale was $36.3 million.

TABLE 5.—Clays sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Fire clay		Miscellaneous clay		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	452	$838	1,262	$2,048	1,714	$2,886
1959	366	565	1,326	2,350	1,692	2,915
1960	348	635	1,474	2,761	1,822	3,396
1961	334	588	1,028	1,858	1,362	2,446
1962	347	569	1,103	1,686	1,450	2,255
1963	448	724	1,098	1,623	1,546	2,347

Gypsum.—The output of crude gypsum continued to increase and was more than 3 percent larger in output and value than in 1962. Underground mines and board plants were operated by National Gypsum Co. and United States Gypsum Co. in Martin County, in the Shoals area. Buildings materials, including lath, plaster, and wallboard, were manufactured.

Mineral Wool.—Mineral wool was manufactured in plants in Huntington, Madison, Wabash, and Wayne Counties. The principal raw material was slag from blast furnaces in Lake County. Small amounts of clay, gravel, and limestone were also used.

Perlite.—Crude perlite, mined in Nevada and New Mexico, was expanded in plants in Lake, Martin, and Scott Counties. It was used principally in concrete aggregate, building plaster, and insulation.

Sand and Gravel.—Production of sand and gravel continued to increase and was more than 7 percent larger than in 1962. Demand for sand and gravel for building and paving use increased by more than 2.1 million tons. Industrial sand output was up about 10 percent. The amount of fill material reported was 0.7 million tons less than in 1962. Commercial production was reported from 67 counties at 213 operations. County highway departments in 18 counties produced sand and gravel.

The largest production of sand and gravel came from Marion County. Large production was also reported from Allen, Franklin, Hamilton, Knox, Kosciusko, La Porte, Madison, St. Joseph, Tippecanoe, and Vigo Counties.

The 10 leading commercial producers, in alphabetical order, were American Aggregates Corp., Interstate Sand & Gravel Co., Inc., Irving Bros. Gravel Co., Inc., Irving Materials, Inc. #2, Manley Sand Division of Martin Marietta Corp., Myers Sand & Gravel Corp., Neal Gravel Co., Inc., S. & L. Gravel Co., Standard Materials Corp., and Western Indiana Aggregates Corp.

Slag (Iron-Blast Furnace).—Slag was a byproduct of pig iron production in Lake County blast furnaces. It was used in the manufacture of roofing granules, mineral wool, and cement, crushed for use as an aggregate, and expanded for lightweight aggregate.

TABLE 6.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Glass	27	$94	(1)	(1)
Building	3,720	3,020	3,963	$3,346
Paving	3,625	2,864	4,089	3,432
Fill	1,331	503	1,190	538
Railroad ballast	8	5	(1)	(1)
Undistributed [2]	775	1,150	903	1,306
Total	9,486	[3] 7,635	[3] 10,146	[3] 8,621
Gravel:				
Building	2,852	3,218	3,487	4,070
Paving	6,435	6,525	6,967	6,729
Railroad ballast	134	69	122	96
Fill	1,855	956	1,343	703
Other	76	63	82	78
Total	11,352	10,831	12,001	[3] 11,677
Total sand and gravel	20,838	18,466	22,147	[3] 20,299
Government-and-contractor operations:				
Sand:				
Building	11	5	1	(4)
Paving			1	(4)
Other			15	5
Total	11	5	[3] 16	[3] 6
Gravel:				
Paving	358	203	659	373
Fill	31	9	16	6
Other	23	8	1	(4)
Total	412	[3] 221	[3] 677	379
Total sand and gravel	423	226	693	385
All operations:				
Sand	9,497	7,640	10,162	8,627
Gravel	11,764	[3] 11,051	12,678	12,056
Grand total	21,261	[3] 18,692	22,840	20,683

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes blast and filtration (1962), molding, engine, foundry, and other construction and industrial sands (1962–63), fire or furnace (1963), and items indicated by footnote 1.
[3] Data do not add to total shown because of rounding.
[4] Less than $500.

Stone.—Stone was quarried in 56 counties. Most of the output (99 percent) was crushed and dimension limestone. Small quantities of calcareous marl and sandstone were also reported. About 97 percent of the stone was crushed for use in cement, concrete aggregate, roadstone, filler, flux, mineral food, railroad ballast, and agricultural limestone. Stone production was about 5 percent larger than in 1962. Crushed stone for agricultural use represented 57 percent of the increase and stone for cement accounted for 31 percent.

Crushed and broken limestone was produced in 44 counties. The largest output was reported from Allen, Clark, Lawrence, and Putnam Counties. The leading crushed stone producers were Bloomington Crushed Stone Co., Inc., Louisville Cement Co., May Stone & Sand, Inc., Mulzer Bros., Newton County Stone Co., Inc., The Ohio &

Indiana Stone Corp., Standard Materials Corp., Utica Limestone Quarry (Louisville Sand & Gravel Co.), Western Indiana Aggregate Corp., and Yeoman Stone Co.

The Indiana Geological Survey published a bulletin on high-calcium limestone and dolomite in Indiana [3] and a map showing locations of aggregate operations in Indiana.[4]

About the same quantity of dimension limestone was produced in 1963 as in the previous year. These data reflect the output of integrated stone producers, who operated both quarries and mills in Lawrence and Monroe Counties. Production of independent stone mills who fabricated rough block purchased from local quarries is excluded. These independent mills, located in the Bloomington-Bedford area, produced building stone valued at more than $5 million in 1963.

TABLE 7.—Limestone sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension and building:				
Rough construction, thousand short tons	(1)	(1)		
Flagging and rubble, do	172	$633	205	$716
Rough architectural, thousand cubic feet	2,467	2,695	2,183	2,533
Sawed stone [2], do	1,244	2,715	1,438	3,453
House stone veneer, do	1,183	1,959	1,080	1,763
Cut stone, do	559	3,251	530	2,258
Total (approximate thousand short tons) [3]	568	11,253	584	[4] 10,724
Crushed and broken:				
Riprap, thousand short tons	120	162	183	278
Concrete aggregate, roadstone, etc., do	13,416	17,365	13,408	17,657
Railroad ballast, do	233	288	283	352
Agricultural, do	1,972	2,751	2,520	3,636
Cement, do	2,074	1,487	2,371	1,748
Other [5], do	240	691	229	659
Total, do	18,055	[4] 22,745	[4] 18,993	[4] 24,329
Grand total, do	18,623	33,998	19,577	35,053

[1] Figure withheld to avoid disclosing individual company confidential data; included with total.
[2] Excludes house stone veneer.
[3] Average weight of 145 pounds per cubic foot used to convert cubic feet to short tons.
[4] Data do not add to total shown because of rounding.
[5] Includes limestone for mineral food, poultry grit, metallurgical, asphalt filler, fertilizer, dust for coal mines, filter beds, stone sand, and other uses.

TABLE 8.—Calcareous marl production

Year	Number of producers	Short tons	Value	Year	Number of producers	Short tons	Value
1954–58 (average)	7	61,765	$39,892	1961	9	31,707	$19,137
1959	8	62,589	39,979	1962	16	50,952	34,657
1960	9	56,406	38,389	1963	17	59,265	36,635

[3] McGregor, Duncan J. High-Calcium Limestone and Dolomite in Indiana. Indiana Geol. Survey Bull. 27, 1963, 76 pp.
[4] McGregor, Duncan J. Locations of Aggregate Operations in Indiana, Indiana Geol. Survey Miscellaneous Map No. 9, 1963.

Leading dimension stone producers included Bloomington Limestone Corp., Empire Stone Co., Indiana Limestone Co., Inc., Victor Oolitic Stone Co., and Woolery Stone Co., Inc.

Calcareous marl was produced from pits in nine counties. The principal production came from Elkhart, Kosciusko, Lagrange, and La Porte Counties.

Sandstone was quarried in Lawrence, Martin, Monroe, and Spencer Counties. With the exception of a quartz conglomerate quarried in Martin County and crushed for use in manufacturing refractories, the sandstone was used chiefly for building purposes.

Sulfur.—Byproduct sulfur was recovered from crude petroleum at the Whiting Refinery of American Oil Co. The Mathieson-Fluor process was used.

MINERAL FUELS

Coal (Bituminous).—Coal production declined about 4 percent in volume and 5 percent in value from the previous year. Much of the loss was due to smaller requirements of electric utility companies who were the principal consumers of Indiana coal. Of 64 mines operated, 5 fewer than in 1962, 26 were underground mines and 38 were strip mines. More than 11.1 million tons of coal was mechanically cleaned at 15 plants. Nearly 10.5 million tons of coal was moved by rail, 1.7 million by water, and 2.1 million by truck, and most of the remainder by conveyors.

Mining-equipment sales to Indiana coal producers included one continuous-mining machine. Sixty mobile loaders and nine continuous mining machines were in use. More than 99 percent of coal mined underground was loaded mechanically.

Coal was mined in 15 counties, but nearly seven-eighths of the production came from mines in Greene, Pike, Sullivan, Vigo, and Warrick Counties. The Indiana Geological Survey published a map showing active coal mine locations.[5]

Coke.—Coke was produced at 5 plants with 2,218 ovens, the same number as in 1962. Output was 7.5 million tons, compared to 7 million in 1962. About 10.8 million tons of coal was delivered to the coke plants and carbonized. Most of the coking coal came from Kentucky and West Virginia. None was mined in Indiana. Most of the coke produced in Indiana was used in Lake County blast furnaces.

Peat.—Peat (humus and moss) was produced from bogs in Benton, Grant, Hamilton, Huntington, Kosciusko, and Marion Counties. In 1963, six producers reported production, compared to five in 1962. Production was at about the same level as in the previous year. Peat was sold principally for horticultural use and soil-conditioning. None was sold for use as fuel.

Petroleum and Natural Gas.—Preliminary figures indicated a decrease in the quantity of oil produced in 1963 from 1962. The total number of well completions also decreased—from 1,525 in 1962 to 1,104 in 1963, or 27.5 percent. Of these 1,104 wells, 743 were drilled in search for oil or gas, 231 were for secondary recovery purposes, and 130 were in connection with gas storage projects.

[5] Hutchison, Harold C. Map of Southwestern Indiana Showing Locations of Active Coal Mines. Indiana Geol. Survey, Miscellaneous Map No. 7. 1963.

TABLE 9.—Coal (bituminous) production in 1963, by counties

(Excludes mines producing less than 1,000 short tons)

County	Number of mines operated		Production (short tons)			Value
	Underground	Strip	Underground	Strip	Total	
Clay		7		1,025,865	1,025,865	$3,857,806
Daviess		1		32,135	32,135	149,402
Dubois	2		7,790		7,790	31,158
Fountain		1		(1)	(1)	(1)
Gibson	2		556,076		556,076	2,381,250
Greene	1	6	1,800	1,528,622	1,530,422	5,862,566
Knox	1		23,089		23,089	94,434
Owen		2		(1)	(1)	(1)
Parke		1		7,577	7,577	28,490
Pike	4	4	114,659	1,820,632	1,935,291	7,178,171
Spencer	1	4	4,972	68,730	73,702	(1)
Sullivan	5	1	1,689,767	8,264	1,698,031	6,964,024
Vermillion	2		11,579		11,579	69,474
Vigo	3	1	1,365,401	596,725	1,962,126	7,841,375
Warrick	5	10	385,063	5,413,511	5,798,574	20,487,980
Total	26	38	4,160,196	10,939,483	15,099,679	57,119,761

[1] Figure withheld to avoid disclosing individual company confidential data; included in total.

TABLE 10.—Peat production

Year	Number of producers	Short tons	Value	Year	Number of producers	Short tons	Value
1954–58 (average)	7	11,678	$92,478	1961	7	57,146	$501,850
1959	5	15,393	202,094	1962	5	47,430	272,238
1960	7	27,486	290,338	1963	6	47,695	411,848

TABLE 11.—Crude petroleum production in 1963, by major fields

Name of field	Year discovered	Area, acres	Location, county	Number of wells		Production barrels
				Producing	Completed	
Belknap	1947	260	Vanderburgh	21	1	111,834
Caborn Consolidated	1940	1,700	Posey	130	0	281,989
Claypole Hills Consolidated	1944	410	Knox	32	1	162,120
Coe South	1961	370	Pike	18	11	115,155
Evansville	1947	390	Vanderburgh	25	0	137,631
Glezen	1952	330	Pike	22	2	167,380
Griffin Consolidated	1938	7,080	Gibson and Posey	677	23	2,352,301
Heusler Consolidated	1938	1,960	Posey and Vanderburgh	118	10	452,116
Lamott Consolidated	1941	1,360	Posey	98	3	109,954
Monroe City Consolidated	1950	1,800	Knox	101	3	100,983
Mount Vernon Consolidated	1941	2,140	Posey	177	5	591,115
Mumford Hills	1940	1,000	Gibson and Posey	67	2	153,369
Owensville Consolidated	1940	1,780	Gibson	143	4	210,179
Owensville North Consolidated	1943	1,890	----do	83	0	260,574
Patoka East Consolidated	1947	1,000	----do	66	0	116,528
Plainville	1950	350	Daviess	55	0	100,171
Powells Lake Consolidated	1942	460	Posey	43	0	119,549
Princeton North Consolidated	1943	830	Gibson	55	0	166,238
Springfield Consolidated	1946	2,360	Posey	259	6	1,064,320
Union-Bowman (New) Consolidated.	1941	14,730	Gibson, Knox, and Pike	591	36	818,097
Vienna	1933	320	Vanderburgh	44	0	101,801
Welborn Consolidated	1941	1,610	Posey	135	0	142,609
West Hovey	1944	450	----do	22	20	224,274
Undistributed				2,967	191	3,831,220
Total				5,949	318	11,891,507

Source: Petroleum Section, Indiana Geological Survey.

Of the 743 wells drilled for oil and gas, 376 were development wells which resulted in 213 oil wells, 11 gas wells, and 152 dry holes. The remaining 367 were exploratory wells, which resulted in 10 new-field discoveries, 26 new-pool discoveries, and 23 pool extensions.

Although drilling was carried on in 35 counties, 89 percent of the total wells drilled was in 10 counties: Posey, 129; Spencer, 116; Gibson, 110; Pike, 89; Dubois, 74; Perry, 47; Daviess, 27; Knox, 24; Clay, 23; and Vanderburgh, 21.

Approximately 53 percent of the total oil production in Indiana in 1963 was the result of secondary recovery operations.

Exploration in Mississippian rocks continued to be most successful, with 9 new fields, 23 new pools, and 21 extensions. One new field and one extension were discovered in Devonian rocks, and three new pools and one extension in Pennsylvanian rocks.

Interest in testing the Salem and Harrodsburg Limestones (Lower Mississippian) increased with the successful completion, in these formations, of two development and five exploratory wells. Porous fossiliferous zones seemed to be the source of oil rather than structural anomalies.

The proved oil reserve, at the end of 1963, was 63,432,000 barrels, and the total liquid hydrocarbon reserve was 63,527,000 barrels.[6]

METALS

Aluminum.—Aluminum Company of America operated a smelter in Warrick County. A rolling mill was under construction adjacent to the smelter and was scheduled for operation in 1964. The company also operated fabricating plants in Fort Wayne, Lafayette, and Richmond. The Lafayette plant produced the helium containers for the Saturn V moon rocket—the largest aluminum extruded tube on record.

Pig Iron and Steel.—Pig iron and steel were produced at East Chicago by Inland Steel Co. and Youngstown Sheet & Tube Co., and at Gary by United States Steel Corp. Output of pig iron was nearly 10.0 million tons, compared with 8.8 million tons in 1962.

The American Iron and Steel Institute reported that steel production in Indiana exceeded 15.5 million tons, up from 14 million in 1962. Nearly 7.1 million tons of coke and coke breeze and 3.7 million tons of limestone and dolomite were used at integrated steel plants.

The industrial complex in northern Indiana continued to expand. At Burns Ditch in Porter County, construction of the $750 million plant of Bethlehem Steel Co. was underway. Scheduled for construction first was a sheared plate mill of 800,000 square feet. United States Steel Corp. announced in September that it would build three oxygen steelmaking furnaces at its Gary Steel Works. Inland Steel Co. announced in June that work would start immediately on the company's first oxygen steelmaking furnaces and new primary rolling mills at its Indiana Harbor Works in East Chicago. Youngstown Sheet & Tube Co. announced a $250 million expansion program

[6] American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. 1963, Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas, v. 18, 31 pp.

in May. The first step will be construction of a $80 million cold-rolled-sheet mill at its Indiana Harbor Works. An additional $15 million will be spent to fill in 70 acres of Lake Michigan for the mill site.

REVIEW BY COUNTIES

Mineral production valued at more than $1 million was reported from each of 21 counties. Petroleum and natural gas were not included in this production.

About 55 percent of the State total came from 10 counties: Cass, Clark, Lake, Lawrence, Monroe, Pike, Putnam, Sullivan, Vigo, and Warrick. Production of cement, coal, and dimension stone was concentrated in these counties. No mineral production was reported from Brown, Ohio, and Union Counties. Petroleum and natural gas production and value are included in the State total, but a breakdown by counties was not available.

Nearly two-thirds of the petroleum was estimated to have come from fields in Gibson and Posey Counties. As some fields extend over parts of more than one county, actual county production cannot be determined.

Only those counties with significant production or activity in the mineral industry are discussed; see table 12 for additional detail.

Adams.—Clay mined from a pit near Decatur was used in manufacturing heavy clay products by Krick-Tyndall Co. Meshberger Bros. Stone Corp. operated limestone quarries and crushing plants at Linngrove and Pleasant Mills. Roadstone and agricultural limestone were produced. John W. Karch Stone Co., Geneva, quarried limestone for use as road material, agricultural purposes, and flagging. Sand and gravel for building and paving use was produced by Lybarger Gravel Co., Geneva, and Yost Gravel Ready Mix, Inc., Decatur. S. & L. Gravel Co. produced road gravel with a portable plant.

TABLE 12.—Value of mineral production in Indiana, by counties[1 2]

County	1962	1963	Mineral production in 1963 in order of value [2]
Adams	$529,939	$586,713	Stone, sand and gravel, clays.
Allen	(3)	1,893,952	Stone, sand and gravel.
Bartholemew	(3)	(3)	Do.
Benton	(3)	(3)	Peat.
Blackford	(3)	(3)	Stone, sand and gravel, clays.
Boone	117,182	100,450	Sand and gravel.
Carroll	(3)	(3)	Stone, sand and gravel.
Cass	1,208,821	(3)	Cement, stone, sand and gravel.
Clark	(3)	(3)	Cement, stone, clays, sand and gravel.
Clay	4,500,904	4,070,814	Coal, clays.
Clinton	37,132	56,551	Sand and gravel.
Crawford	(3)	(3)	Stone.
Daviess	266,087	206,002	Coal, sand and gravel.
Dearborn	241,248	(3)	Sand and gravel.
Decatur	(3)	(3)	Stone.
De Kalb	378,287	281,323	Sand and gravel.
Delaware	1,039,037	1,400,088	Stone, sand and gravel.
Dubois	66,011	33,401	Coal, clays.
Elkhart	435,134	403,276	Sand and gravel, stone.
Fayette	(3)	(3)	Sand and gravel.
Floyd	(3)	(3)	Stone.
Fountain	493,279	(3)	Sand and gravel, clays, coal.
Franklin	(3)	(3)	Sand and gravel, clays.
Fulton	21,658	39,362	Sand and gravel, stone.

See footnotes at end of table.

TABLE 12.—Value of mineral production in Indiana, by counties [1] [2]—Continued

County	1962	1963	Mineral production in 1963 in order of value [2]
Gibson	(3)	$2,436,728	Coal, sand and gravel.
Grant	(3)	(3)	Stone, sand and gravel, peat.
Greene	$6,399,621	6,032,518	Coal, clays, sand and gravel.
Hamilton	1,273,944	954,031	Sand and gravel, stone peat.
Hancock	54,832	49,526	Sand and gravel.
Harrison	233,253	231,025	Stone.
Hendricks	(3)	(3)	Sand and gravel.
Henry	(3)	(3)	Do.
Howard	(3)	(3)	Stone.
Huntington	(3)	748,189	Stone, sand and gravel, clays, peat.
Jackson	139,414	147,878	Clays, sand and gravel.
Jasper	397,457	(3)	Stone, sand and gravel.
Jay	(3)	(3)	Do.
Jefferson	(3)	(3)	Stone.
Jennings	264,188	143,263	Do.
Johnson	244,500	310,510	Sand and gravel.
Knox	855,340	655,801	Sand and gravel, coal.
Kosciusko	605,208	563,576	Sand and gravel, stone, peat.
Lagrange	81,344	(3)	Sand and gravel, stone.
Lake	(3)	(3)	Cement, clays, sand and gravel.
La Porte	866,709	(3)	Sand and gravel, stone.
Lawrence	11,330,475	11,309,010	Cement, stone.
Madison	1,140,676	1,445,738	Stone, sand and gravel.
Marion	(3)	(3)	Sand and gravel, peat.
Marshall	58,240	(3)	Sand and gravel, stone.
Martin	3,555,392	3,523,105	Gypsum, clays, stone.
Miami	239,521	352,422	Sand and gravel.
Monroe	6,895,791	7,662,089	Stone.
Montgomery	78,873	(3)	Clays, sand and gravel.
Morgan	507,467	742,191	Clays, sand and gravel, stone.
Newton	(3)	(3)	Stone, sand and gravel.
Noble	169,103	351,199	Sand and gravel, stone.
Orange	498,354	528,641	Stone, abrasives.
Owen	2,825,753	(3)	Coal, stone, clays, sand and gravel.
Parke	317,601	(3)	Clays, sand and gravel, coal.
Perry	(3)	(3)	Stone.
Pike	6,416,810	7,183,043	Coal, stone.
Porter	(3)	(3)	Sand and gravel, clays.
Posey	73,372	(3)	Sand and gravel.
Pulaski	(3)	(3)	Stone, clays, sand and gravel.
Putnam	(3)	(3)	Cement, stone, sand and gravel.
Randolph	322,833	370,865	Stone, sand and gravel.
Ripley	492,479	325,861	Stone.
Rush	(3)	(3)	Stone, sand and gravel.
St. Joseph	757,826	753,811	Sand and gravel, stone.
Scott	182,123	201,714	Stone.
Shelby	754,235	885,147	Stone, sand and gravel.
Spencer	411,967	413,815	Coal, stone, sand and gravel.
Starke	33,696	37,251	Sand and gravel.
Steuben	275,570	192,558	Sand and gravel, stone.
Sullivan	6,872,350	7,155,410	Coal, sand and gravel, stone.
Switzerland	112,696	121,754	Stone, sand and gravel.
Tippecanoe	(3)	(3)	Sand and gravel.
Tipton	(3)	(3)	Do.
Vanderburgh	(3)	(3)	Stone, clays.
Vermillion	744,749	746,298	Sand and gravel, clays, coal.
Vigo	9,393,587	8,569,883	Coal, sand and gravel, clays.
Wabash	(3)	179,954	Stone, sand and gravel.
Warren	388,158	514,541	Sand and gravel.
Warrick	22,348,796	20,611,473	Coal, stone, sand and gravel.
Washington	(3)	(3)	Stone, sand and gravel.
Wayne	835,243	909,400	Sand and gravel, stone.
Wells	(3)	(3)	Stone, sand and gravel.
White	280,750	267,200	Stone.
Whitley	401,370	96,787	Sand and gravel.
Undistributed	[4] 103,960,128	105,733,863	
Total	[4] 203,426,000	202,530,000	

[1] Brown, Ohio, and Union Counties did not report production.
[2] Natural gas and petroleum production is not available by counties; included with "Undistributed."
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Revised figure.

Allen.—May Stone & Sand, Inc., operated limestone quarries at Fort Wayne and Woodburn. Fluxstone, road material, and agricultural limestone were produced. During the year the company added secondary crushing units, a screen, and a conveyor to its processing plant. Midwest Aggregates Corp., Division of Old Fort Supply Co., Inc., operated a quarry and crushing plant at Edgerton and produced road materials. In the Fort Wayne area Paul C. Brudi Stone & Gravel Co., Inc., and May Stone & Sand, Inc., mined and processed sand and gravel for building and road use. The W. W. Gravel Co., Inc., operated a sand and gravel pit and plant near Roanoke, and S. & L. Gravel Co. operated a portable plant in the county.

During the year construction began on a bulk cement distribution plant in Fort Wayne for the Peerless Cement Co., Division of American Cement Corp. Four 85-foot concrete silos will provide bulk storage and shipping facilities for northeastern Indiana.

Bartholomew.—Meshberger Stone Corp. operated a limestone quarry and processing plant in the Columbus area and produced roadstone, agricultural limestone, filler, material for filter beds, stone sand, and flux. Paul Carter operated a dredge near Columbus and produced building material and fill.

Benton.—Milburn Peat Co., Inc., produced moss peat from a bog near Otterbein. The moss peat was sold in both bulk and packaged form for horticultural use and soil conditioning. The Mt. Gilboa Gravel Co. did not operate in 1963.

Blackford.—Inman Tile Co. manufactured draintile from clay mined near Hartford City. J. & K. Stone Corp. Division of Old Fort Supply Co., operated the Montpelier quarry and crushed limestone for building, concrete aggregate, roadstone, and agricultural use.

S. & L. Gravel Co. produced road gravel with a portable plant.

Hartford Peat & Gravel Co. did not report peat production from their bog near Hartford City.

Carroll.—Limestone was quarried and crushed near Delphi by Delphi Limestone Co. It was used for road material and agricultural purposes. The county highway department produced road gravel for its own use. Gravel for building use and fill was obtained from pits near Flora and Delphi.

Cass.—Louisville Cement Co. produced portland and masonry cements at its Logansport plant. The company operated the Logansport quarry and produced limestone for its own use. Limestone quarries were also operated near Logansport by Cass County Stone Corp. and The France Stone Co. Riprap, fluxstone, road materials, and agricultural limestone were produced. Sand and gravel for building and road use was produced in the county with both fixed and portable plants.

Clark.—Portland and masonry cements were produced at Speed by Louisville Cement Co. Clay and limestone for use at the plant were mined in the area. Limestone quarries and crushing plants were operated at Jeffersonville by T. J. Atkins & Co., Inc., at Sellersburg by Sellersburg Stone Co., Inc., and at Utica by Louisville Sand & Gravel Co., Inc. The material was used principally as road material and for agricultural purposes. Sand and gravel was produced in the Jeffersonville area, chiefly for building and road use.

Clay.—Coal was produced from six strip mines. The Peanut mine of R. & L. Trucking, Inc., did not operate in 1963. The Chinook mine of Ayrshire Collieries Corp. again was the largest producer in the county. Fire clay and miscellaneous clay were mined at several sites in the county. The material was used in cement, refractories, floor and wall tile, and heavy clay products. Burwin Quarries, Inc., Coalmont, did not operate their limestone quarry in 1963.

Crawford.—Mulzer Bros. operated the Eckerty quarry and Hy-Rock Products Co. operated an underground quarry at Marengo. The limestone was crushed and used for flux, railroad ballast, road material, and agriculture.

Daviess.—P. & R. Coal Co. operated a strip mine. Sand and gravel for building, paving, and fill was mined near Elnora by Mize Gravel Co.

Decatur.—Harris City Stone Co., Inc., and New Point Stone Co. operated limestone quarries and processing plants at Greensburg and New Point, respectively. Riprap, road materials, and agricultural limestone were produced.

Delaware.—Limestone quarries and crushing plants were operated in the Muncie area by Irving Bros. Stone & Gravel Co., J. & K. Stone Corp., and Muncie Stone & Lime Co. Sand and gravel for building, paving, and fill was produced at several sites in the county.

Dubois.—Two underground coal mines—the Ackerman and the Frick—were operated during the year. The Stenftenagel Coal Co. did not operate in 1963. Hugo H. Bartelt mined fire clay from an underground mine near Huntingburg and sold it to stoneware manufacturers. The Hoffman Sand & Gravel pit near Portersville was closed early in the year and did not produce.

Elkhart.—Marl was dug from pits near Elkhart and Middlebury and sold for agricultural use. Sand and gravel was produced at several sites in the Elkhart-Goshen area. The material was used for building, paving, and fill.

Floyd.—Standard Materials Corp. operated a limestone quarry and crushing plant near Greenville. Road materials and agricultural limestone were produced.

Fountain.—Clay was mined from pits near Veedersburg and West Point. It was used in the manufacture of building brick and inorganic plastic. Coal was produced from the Maple Grove strip mine. Sand and gravel was mined and processed at Attica by Neal Gravel Co., Inc., and at Kingman by Towell & Towell. The latter company's pit was closed down in October.

Franklin.—The Batesville Brick & Tile Co. operated a clay pit near Batesville for its own use. Standard Materials Corp. operated sand and gravel pits and processing plants at Metamora and New Trenton for production of building and road materials. The county highway department operated a portable sand and gravel plant.

Fulton.—Pits near Akron and Rochester yielded marl for agricultural use. Zartman's South Mud Lake pit near Macy was inactive during 1963. Sand and gravel for building, paving, and fill was mined in the Rochester area.

Gibson.—Coal was produced from the Kings Station mine (Princeton Mining Co.) and the Somerville No. 1 mine (Somerville Coal Co.).

Installation of two centrifugal dryers at the Kings Station mine was completed in June. Sand and gravel, chiefly for fill and road use, was produced at several sites.

Grant.—Pipe Creek Stone Co. quarried limestone near Sweetser. Flagstone and riprap, as well as crushed material for flux, roadstone, railroad ballast, and agricultural purposes, were produced. Glacier Peat Moss Corp. obtained peat from a bog near Jonesboro. Sand and gravel was mined near Marion.

Greene.—Coal was produced from six strip mines and one underground mine. The South Linton Coal Co.'s underground mine was abandoned in 1962. Clays (fire and miscellaneous) were mined near Bloomfieid and Switz City and were used for making heavy clay products. Sand and gravel for building, paving, and fill was produced at two sites near Bloomfield.

Hamilton.—Stony Creek Stone Co., Inc., operated a limestone quarry and crushing plant near Noblesville. Roadstone and agricultural limestone were produced. Sand and gravel for building, road use, and fill was mined at several sites. Peat was obtained from a bog near Noblesville.

Harrison.—Limestone was quarried and crushed near Corydon by Corydon Crushed Stone & Lime Co. and Mathes Stone Quarry and at Ramsey by Davis Crushed Stone & Lime Co. Most of the material was used for concrete aggregate, roadstone, and agricultural purposes.

Howard.—Yeoman Stone Co. produced riprap, roadstone, and agricultural limestone from a quarry near Kokomo.

Huntington.—Draintile was manufactured from clay mined near Majenica and Simpson. A bog near Warren yielded moss peat for horticultural use and soil conditioning. Limestone was quarried and crushed by Erie Stone Co. at Huntington and by Heller Stone Co., Inc., at Markle. Sand and gravel was produced from pits near Andrews and Huntington.

Jackson.—Lehigh Portland Cement Co. mined shale for use at its Mitchell plant. Pits near Brownstown and Medora yielded clay for use in making building brick and other heavy clay products. Sand and gravel was produced near Brownstown and Seymour and used for building, fill, and road construction and maintenance.

Jasper.—Sand and gravel for ice control, road construction, and building purposes was produced in the Rensselaer area. W. C. Babcock Construction Co., Inc., operated a limestone quarry and crushing plant near Rensselaer and produced material for concrete aggregate, roadstone, and agricultural use.

Jay.—Rockledge Products, Inc., quarried and crushed limestone near Portland for road and agricultural use. Road gravel was produced with a portable plant by S. & L. Gravel Co. The Irvin Gravel & Supply pit near Pennville was idle during the year.

Jefferson.—Standard Materials Corp. operated the Hanover quarry near Hanover and produced riprap, roadstone, and agricultural limestone.

Jennings.—The North Vernon quarry was operated by Berry Materials Corp. and produced agricultural limestone and road materials.

Knox.—Coal was produced from the White Ash underground mine. The Enoco mine of Enoco Collieries, Inc., was abandoned in March,

1962. Over 600,000 tons of sand and gravel was produced, mostly in the Vincennes area, for building, paving, and fill.

Kosciusko.—Pits near Milford, Silver Lake, and Atwood yielded marl for agricultural use. Moss peat was dug from a bog near Silver Lake. Over 700,000 tons of sand and gravel was produced at fixed plants near Leesburg, Syracuse, and Warsaw and at portable plants throughout the county.

Lagrange.—Marl, for agricultural use, was obtained from pits near Howe and Middlebury. Sand and gravel pits near Howe, Lagrange, and Wolcottville yielded building and road materials, and fill.

Lake.—Portland and masonry cements were produced by Universal Atlas Cement Division of United States Steel Corp., at Buffington. Slag from Lake County blast furnaces and limestone, water transported from Michigan quarries to the plant's port facilities, were the principal raw materials used. National Brick Co. manufactured brick from clay mined near Munster. Industrial sands were mined at the Dune Park pit by John N. Bos Sand Co. Building and road materials and fill were obtained from sand and gravel pits near Griffith and Lowell. Crude perlite, mined in New Mexico, was expanded by Federal Cement Products, Inc., at Hammond for use in concrete aggregate. Roofing granules were manufactured from slag by H. B. Reed Co., Hammond. Byproduct sulfur was recovered from crude petroleum at Whiting by American Oil Co. Pig iron and steel were produced by United States Steel Corp. at Gary and by Inland Steel Co. and Youngstown Sheet & Tube Co. at East Chicago.

La Porte.—Marl for agricultural use was obtained from pits near La Porte and Walkerton. Industrial sands were mined at Michigan City by Manley Sand Division of Martin Marietta Corp. Road and building materials were obtained from sand and gravel pits near Hanna and La Porte.

Lawrence.—In the Bedford area dimension limestone was produced by companies who operated both quarries and mills. Several independent mills fabricated stone purchased locally. In January the Hoosier-Joyner stone mill of Indiana Limestone Co. was severely damaged by a $2 million fire. Finely ground limestone for use in mineral food, glass manufacture, and agriculture was produced by Bedford Ground Limestone Co. Crushed limestone for cement, concrete aggregate, and agricultural purposes was produced by Bloomington Crushed Stone Co., Inc., at Springville, Mitchell, Crushed Stone Co., Inc., and Lehigh Portland Cement Co. at Mitchell and Oolitic Ground Limestone Co. at Bedford. Portland and masonry cements were manufactured at Mitchell, by Lehigh Portland Cement Co. Sandstone was quarried and milled, principally for building purposes, by French Lick Sandstone Co., Inc., Indiana Sandstone Co., Inc., Leonard Sandstone Co., Inc., Spice Valley Sandstone Co., Inc., and Springs Valley Sandstone Co.

Madison.—Standard Materials Corp. operated a limestone quarry at Lapel and produced riprap, road material, and agricultural limestone. More than 700,000 tons of sand and gravel was produced, mostly in the Anderson area.

Marion.—The county ranked first in the State in sand and gravel production. American Aggregates Corp. and Standard Materials

Corp. operated several pits and processing plants. Fisher Oil & Gravel Co., Inc., National Aggregate Corp., and Spickelmier Industries, Inc., also reported production of sand and gravel. Most of the Marion County output was used for building and highway construction and fill. Peat Moss, Inc., produced humus peat from a bog in the Indianapolis area.

Marshall.—A pit near Bremen yielded marl for agricultural use. Building and road materials, and fill were obtained from sand and gravel pits near Argos, Bremen, and Culver.

Martin.—Gypsum was obtained from underground mines near Shoals by National Gypsum Co. and United States Gypsum Co. The crude ore was processed at mills adjoining the mines and manufactured into plaster, wallboard, and other building materials. Brick and tile were manufactured from clay mined near Loogootee. Sandstone was quarried at Trinity Springs and milled at French Lick. General Refractories mined a quartz conglomerate near Shoals for use in making refractories.

Monroe.—Limestone was quarried for building purposes by Leo Bennett Stone Co., Bloomington Limestone Corp., Empire Stone Co., B. G. Hoadley Quarries, Inc., Independent Limestone Co., Indiana Limestone Co., Inc., McNeely Quarries, Inc., Midwest Quarries Co., Inc., Victor Oolitic Stone Co., Texas Quarries, Inc., and Woolery Stone Co., Inc. Some of these companies and several independent mills, in the Bedford-Bloomington area, fabricated most of the stone quarried. Bloomington Limestone Corp. made major repairs to the Wylie Mill building and installed a multiple saw at the Maple Hill Mill. Empire Stone Co. installed a new cut stone mill and new diamond saws. Indiana Calcium Corp. operated a fine-grinding plant at Bloomington using spalls purchased from local stone mills. Bloomington Crushed Stone Co., Inc., operated a quarry and crushing plant near Bloomington. Hinkle Sandstone Co. quarried and milled dimension sandstone in the Bloomington area.

Montgomery.—Clay mined from pits near Crawfordsville by American Vitrified Products Co. and Hydraulic-Press Brick Co. was used in the manufacture of building brick and vitrified sewer pipe. Sand and gravel for fill and building construction was obtained from pits near Crawfordsville.

Morgan.—Clayton Winders & Sons operated the Porter-Cave quarry near Gosport and produced limestone used for road materials and agriculture. Clay mined near Brooklyn and Martinsville was used for lightweight aggregate, brick, and sewer pipe. Sand and gravel pits in the Martinsville area yielded materials for building and road use.

Newton.—At Kentland the Newton County Stone Co., Inc., quarried and crushed limestone for road use, railroad ballast, and agricultural purposes. The Morocco Sand & Gravel Co. operated a pit near Morocco and produced building and paving materials.

Noble.—Marl for agricultural use was obtained from pits near Albion and Topeka. Sand and gravel was produced with both fixed and portable plants throughout the county. Most of the material was used for building and paving.

Orange.—Sandstone quarried in Lawrence and Martin Counties was fabricated into building material at French Lick. Limestone quarries and crushing plants were operated at French Lick, Orleans, and Paoli. A mill near Orleans manufactured whetstones from material quarried nearby.

Owen.—Coal was produced from two strip mines by Burcham Bros., Inc., and Peabody Coal Co. Peabody Coal Co. also mined fire clay from the Old Glory mine and sold it to manufacturers of heavy clay products, terra cotta, and tile. Limestone was quarried and crushed at Spencer for use as road material and agricultural purposes. Sand and gravel was mined near Gosport and Spencer for building and road use.

Parke.—Coal was mined from the Turner strip mine. The Maple Grove strip mine was abandoned in April, 1962. Fire clay used for building brick was obtained from the Turner mine. The Cayuga Brick & Tile Co. pit near Bloomingdale, which was inactive in 1962, produced clay for manufacturing heavy clay products. Sand and gravel pits near Montezuma and Rockville yielded building and road materials, and fill.

Perry.—Mulzer Bros. operated the Derby limestone quarry and produced riprap, road materials, and agricultural limestone.

Pike.—Coal was produced from four strip mines and four underground mines. In 1963 Cornell Excavating, Inc., operated the Glezon strip mine in addition to the Cup Creek strip mine. During the year the Enos Coal Mining Co. was acquired by the Interlake Iron Corp. and will be operated as a division of that company. The Miley Coal Co. abandoned its underground mine in October. The county highway department quarried limestone for use as riprap.

Porter.—Charles Lorenz & Son mined fire clay from the Lenburg and Schrock pits near Portage. The material was sold to manufacturers of pottery and refractories. Industrial sand was produced near Portage by Crisman Sand Co., Inc.

Posey.—Posey continued to rank as the leading oil-producing county in the State. Sand and gravel for building and road use was produced near New Harmony and Mount Vernon.

Pulaski.—Clay mined near Francesville was used in manufacturing farm draintile. In the same area limestone was quarried and crushed for use as roadstone, railroad ballast, and agricultural limestone by Western Indiana Aggregates Corp. Doty Bros. pit near Star City yielded sand and gravel for building and road use.

Putnam.—Portland and masonry cements were manufactured at Limedale by Lone Star Cement Corp. The company quarried limestone for its own use. Shale was mined at the Indiana State Farm at Putnamville. Mineral production of the institution was used by State agencies and was not for commercial sale. Limestone quarries and crushing plants were operated by Standard Materials Corp. at Manhattan and Stilesville, by Harris Stone Service, Inc., at Bainbridge, by The Ohio & Indiana Stone Corp. at Greencastle, and by the Russellville Stone Co. Division of Gorman Construction Co., Inc., at Russelville. Sand and gravel for road use was produced at Reelsville.

Randolph.—Portland Stone Corp. operated a quarry at Albany and H. & R. Stone Co. a quarry at Ridgeville. Sand and gravel for building and road construction and fill was produced near Farmland and Lynn. Portable plants also operated throughout the county.

Ripley.—Limestone quarries were operated in the Versailles area by Berry Materials Corp. and Cord Stone Co., near Napoleon by New Point Stone Co., and at Osgood by South Eastern Materials Corp. Riprap, road materials, and agricultural limestone were produced.

Rush.—In the Milroy area limestone was quarried and crushed by McCorkle Stone Co. and Rush County Stone Co. Sand and gravel was produced at several sites with portable plants.

St. Joseph.—Pits near North Liberty and South Bend yielded marl for agricultural use. Nearly 900,000 tons of sand and gravel was produced in the Mishawaka and South Bend areas. Most of it was used for building and road construction.

Scott.—The Scott County Stone Co., Inc., produced limestone from the Hardy quarry at Scottsburg for road material and agricultural limestone. Airlite Processing Corp. expanded crude perlite mined in Western States.

Shelby.—Flagstone and rubble were quarried at Waldron by Blue Ridge Quarries. Quarries and crushing plants at Flat Rock, St. Paul, and Waldron produced limestone for riprap, fluxstone, roadstone, railroad ballast, and agricultural use. Sand and gravel for building, paving, and fill was mined at Morristown and Shelbyville.

Spencer.—Coal was produced from four strip mines and one underground mine. The Hagedorn Coal Co. strip mine was idle in 1963. Sandstone was quarried and milled by St. Meinrad Quarry Industries at St. Meinrad. Building stone and flagging were produced. Hardy Sand Co. produced molding sand from a pit near Richmond.

Steuben.—Marl, for agricultural use, was dipped from Harp's marl pit near Angola. Sand and gravel was produced at fixed plants near Angola and Fremont and at several sites in the county with portable plants.

Sullivan.—Coal was produced at one strip mine and at five underground mines. The Buck Creek Coal Co. underground mine was abandoned in 1963, and the Peabody Coal Co. Airline underground mine reported first production in August. At Freelandville, Kixmiller Bros. quarried limestone, mostly for agricultural use. Sand and gravel was produced at several pits throughout the county. Output was for building and road construction, railroad ballast, and highway ice control.

Switzerland.—Limestone was quarried near Cross Plains and crushed for use as asphalt filler, roadstone, and agriculture. The county highway department produced gravel for its own use.

Vanderburgh.—Mulzer Bros. operated the West Franklin quarry near Evansville and produced road materials and agricultural limestone. Standard Brick & Tile Corp. mined clay for use in manufacturing building brick.

Vermillion.—Coal was obtained from two underground mines. The Blue Bird Coal Co., Inc., abandoned its mine in November 1962. Fire clay was mined at the Dana pit near Hillsdale and used in manufacturing structural tile. Miscellaneous clay, mined near

747-416—64——27

Cayuga, was used for building brick. Sand and gravel pits and processing plants were operated at Cayuga by Material Service Division of General Dynamics Corp. and at Clinton by Standard Materials Corp.

Vigo.—Coal was produced from one strip mine and three underground mines. In August, Peabody Coal Co. announced closing of the Green Valley mine because of unsafe working conditions. The company began development of a new mine at Dugger, south of Terre Haute. In West Terre Haute clay was mined by Terre Haute Vitrified Brick Works, Inc., for its own use. More than 800,000 tons of sand and gravel was produced, mostly in the Terre Haute area for building and road construction.

Wabash.—Mill Creek Stone & Gravel Corp. quarried limestone near Wabash for use as road material and agriculture. Sand and gravel was produced at two fixed plants and several portable plants operating throughout the county.

Warrick.—Coal was produced at 10 strip mines and 5 underground mines. Three of the largest coal mines in the State, all strip operations, are located in the county. The Andrews Coal Co. strip mine began operating in 1963. Crushed stone and sand and gravel for road use were produced near Boonville.

Wayne.—De Bolt Concrete Co., Inc., quarried limestone at Richmond for use as riprap, agriculture, and road construction. Over 600,000 tons of sand and gravel was produced, mostly in the Richmond area. Much of the material was used for road construction and maintenance.

Wells.—Erie Stone Co. operated a quarry and processing plant at Bluffton and produced limestone for flux, railroad ballast, road materials, agricultural use, and riprap. Gravel for road use and fill was mined in the county.

White.—Monon Crushed Stone Co., Inc., operated a limestone quarry and crushing plant near Monon and produced road materials, railroad ballast, and agricultural limestone.

The Mineral Industry of Iowa

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Iowa for collecting information on all minerals except fuels.

By John W. Sweeney [1]

THE value of mineral production in Iowa continued at an accelerated pace in 1963, setting a new record high. The total value of the State's mineral production was $97.7 million, an increase of 1 percent over 1962. Nonmetals accounted for 95 percent and fuels 5 percent of the total value. Slight declines were noted for masonry cement, clays, and stone, but a rising demand for portland cement, coal, gypsum, sand and gravel, lime, and peat more than offset these declines. Coal production continued to increase for the 2d consecutive year. Sales of portland cement showed a 2 percent increase over 1962. Principal commercial minerals were limestone, sand and gravel, gypsum, coal, clays, and peat.

Early in the year, oil was discovered by a pipeline company while drilling for a prospective underground gas storage reservoir in Washington County. The chance discovery, near Keota, represented the initial find of oil in Iowa and resulted in the production and sale of approximately 400 barrels of oil. However, pumping was discontinued November 1, and no production was recorded for the balance of the year.

TABLE 1.—Mineral production in Iowa [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	12,261	$42,417	12,495	$42,891
Masonry—thousand 280-pound barrels	568	1,786	551	1,754
Clays—thousand short tons	1,039	1,427	1,064	1,405
Coal (bituminous)—do	1,130	4,026	1,213	4,244
Gypsum—do	1,256	5,318	1,282	5,667
Petroleum (crude)—thousand 42-gallon barrels			[2]	[2]
Sand and gravel—thousand short tons	13,797	12,474	14,168	12,845
Stone—do	21,618	28,244	20,904	27,788
Value of items that cannot be disclosed:				
Other nonmetals, peat, and value indicated by footnote 3		869		1,076
Total		96,561		97,670

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Less than 500 barrels.
[3] Figure withheld to avoid disclosing individual company confidential data.

[1] Geologist, Bureau of Mines, Minneapolis, Minn.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$57,344	1958	$89,973
1953	53,867	1959	91,098
1954	63,987	1960	98,861
1955	67,924	1961	95,424
1956	68,534	1962	97,594
1957	73,410	1963	98,536

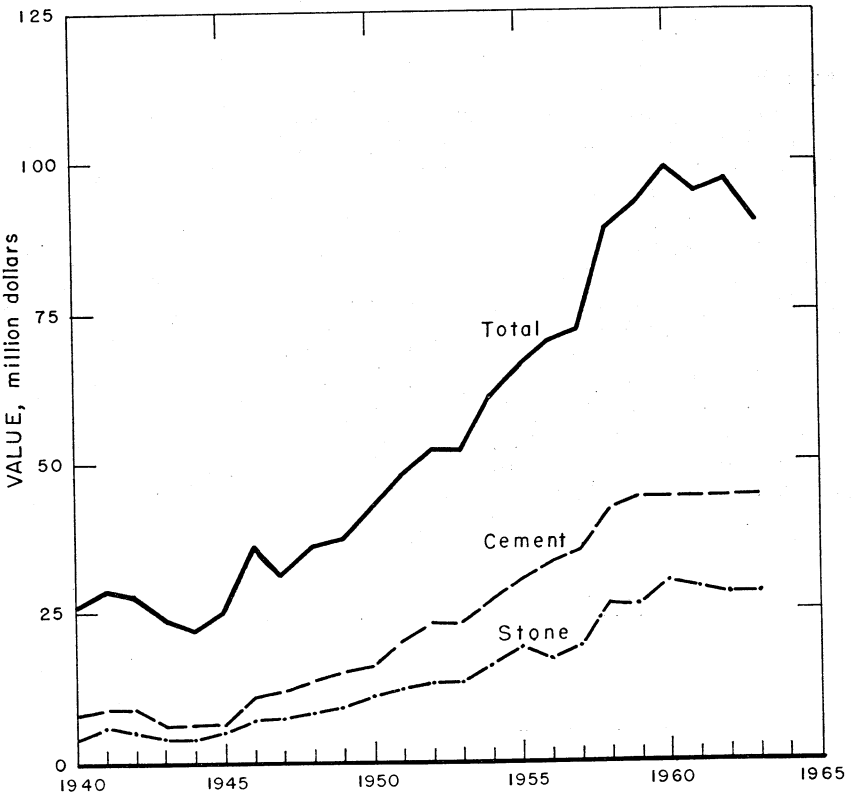


FIGURE 1.—Value of cement, stone, and total value of mineral production in Iowa, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

An aeromagnetic survey report[2] was released which "indicates the presence of rocks that in the Lake Superior region contain commercial deposits of copper." No production of metallic minerals was reported.

Employment and Injuries.—Over 9.7 million man-hours were worked in Iowa mineral industries in 1963, excluding officeworkers. This represented a 1-percent increase over the 9.6 million man-hours reported for 1962.

Four fatalities, two each at limestone and sand and gravel operations, occurred in 1963, the same number as in 1962. The total number of nonfatal disabling injuries decreased to 153 (preliminary figure), compared with the final figure of 160 for 1962.

Table 3 contains a summary of employment and injury data for selected State mineral industries. Certain industries are excluded from the table, primarily to avoid disclosing individual company confidential data.

TABLE 3.—Employment and injuries for selected mineral industries [1]

Year and industry	Average number of men working	Total man-hours	Total number of disabling injuries		Total number of days lost or charged	Injury frequency rate [2]	Injury severity rate [3]
			Fatal	Nonfatal			
1962:							
Cement [4]	979	2,379,648	----	6	270	2.52	113
Clays [5]	758	1,457,839	----	52	1,226	35.67	841
Coal (bituminous)	413	634,185	----	16	978	25.23	1,542
Gypsum	206	429,437	----	----	----	----	----
Limestone [6]	1,464	2,953,882	2	59	18,067	20.65	6,116
Sand and gravel [7]	1,065	1,676,575	1	25	6,487	15.51	3,869
1963: [8]							
Cement [4]	940	2,427,447	----	7	(9)	2.88	(9)
Clays [5]	676	1,398,771	----	31	(9)	22.16	(9)
Coal (bituminous)	400	590,000	----	15	(9)	25.42	(9)
Gypsum	179	388,744	----	----	----	----	----
Limestone [6]	1,431	2,973,540	2	72	(9)	24.89	(9)
Sand and gravel [7]	1,204	1,798,670	2	25	(9)	15.01	(9)

[1] Excludes officeworkers.
[2] Total number of injuries per million man-hours.
[3] Total number of days lost or charged per million man-hours.
[4] Includes cement plants and quarries or pits producing raw material used in manufacturing cement.
[5] Excludes pits producing clay used in manufacturing cement.
[6] Excludes quarries producing limestone used in manufacturing cement and lime.
[7] Excludes friable sandstone.
[8] Preliminary figures.
[9] Data not available.

Water.—To obtain valid data concerning water use by the mineral industries for 1962, the Bureau of Mines conducted a nationwide canvass of virtually all mineral extractive and certain mineral processing industries. Cement plants, lime plants, and other manufacturing operations were excluded. Table 4 summarizes some of the data collected for the State. As used in the table, "new water" is that entering the plant as makeup water and when added to the "recirculated water" gives the total used or required for processing. "Water discharged" is used water leaving the plant. "Water consumed" is that which leaves the plant as moisture combined or en-

[2] Henderson, John R., Walter S. White, and Isidore Zietz. Preliminary Interpretation of an Aeromagnetic Survey in North-Central Iowa. U.S. Geol. Survey. Open File Rept., Apr. 3, 1963, 27 pp.

TABLE 4.—Water statistics for selected mineral industries in 1962

(Million gallons)

Industry	New water	Water re-circulated	Total water used	Water discharged	Water consumed
Limestone	370	85	455	362	9
Sand and gravel	1,640	3,853	5,493	1,604	36
Total	2,010	3,938	5,948	[1] 1,965	45

[1] Data do not add to total shown because of rounding.

trained in the product or lost by evaporation and no longer available for reuse in the vicinity of the plant.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of portland cement totaled 12.5 million 376-pound barrels, a 2-percent increase over that of 1962. The average unit value per barrel, mill, decreased 1 percent to $3.43 in 1963, compared with $3.46 in 1962. Cement plants were operated by Lehigh Portland Cement Co. and Northwestern States Portland Cement Co. in Cerro Gordo County, Marquette Cement Manufacturing Co. and Penn-Dixie Cement Corp. in Polk County, and Dewey Portland Cement Co. in Scott County. Total capacity of these plants approached 16 million barrels per year.

In 1963, Northwestern States Portland Cement Co. added a 400-foot kiln, controlled by a closed-loop computer control system, to its plant at Mason City.

Two of the companies used a dry process and three used a wet process. Raw materials used in manufacturing cement were limestone and clay or shale from local sources, gypsum that was purchased from producers operating in Webster County, and purchased iron ore or mill scale. Twenty-eight kilns were operated by producers. A total of 288 million kilowatt hours of electricity was consumed, about 103 million kilowatts were home-generated and 185 million kilowatts were purchased.

Types I and II, general-use and moderate-heat cements, and type III, high-early-strength cement, were produced at all five plants. Markets for the cement were chiefly in Iowa and Minnesota, followed by Illinois, Wisconsin, Nebraska, North Dakota, South Dakota, Indiana, and Missouri. The cement was shipped by railroad and truck, chiefly in bulk; no movement by boat was reported. Sales of 1.4 million barrels of portland cement were to building material dealers, 2.2 million barrels to concrete product manufacturers, 6.6 million barrels to ready-mixed concrete companies, 2.0 million barrels to highway contractors, and the remainder to other sources.

Mixed hydraulic and masonry cements were produced at all except the Penn-Dixie Cement Corp., plant No. 8, in West Des Moines, Polk County. Sales and total value of masonry cement decreased slightly in 1963, but unit values were higher. The average price

per 280-pound barrel was $3.18, compared with $3.15 in 1962. Market distribution, in order of quantity, was similar to that of portland cement.

Clays.—Shale and clay deposits were mined for use chiefly in manufacturing heavy clay products and cement. Other uses were for lightweight aggregates, vitrified sewer pipe, mortar mix, and in the manufacture of pozzolans. Production of fire clay was reported from Nelson Clay Products Co., Griffin Pipe Products Co., and Ver Steeg Coal Co.; all production was used in manufacturing building brick and vitrified sewer tile. Expandable shale was mined by the Carter-Waters Corp. of Kansas City, Mo., from their shale pit near Centerville, Appanoose County, for manufacturing lightweight aggregate. Sales of crude clay were reported by 4 of the 27 companies reporting production. The other companies used their entire output in their own plants. Companies selling crude clay were Nelson Clay Products Co. in Keokuk County, Ver Steeg Coal Co. in Marion County, Goodwin Tile and Brick Co. in Polk and Warren Counties, and Vincent Clay Products Co. in Webster County.

Of the total shale and clay produced, 46 percent was used in manufacturing portland cement and 44 percent was used in heavy clay products. The remainder was used chiefly in lightweight aggregate, mortar, and masonry cement.

Shale or clay pits were operated by 27 firms in 17 counties. Iowa Clay Pipe Co., Polk County, reported initial production of clay in 1963.

Gypsum.—Iowa continued to be one of the Nation's major producers of gypsum and gypsum products. In 1963, the State was third in total production, following California and Michigan. Production for Iowa in 1963 increased 2 percent in quantity and 7 percent in total value, paralleling the rise in building construction.

Gypsum was mined and processed by United States Gypsum Co. in Des Moines and Webster Counties and by Bestwall Gypsum Co., The Celotex Corp., and National Gypsum Co. in Webster County. Products include gypsum lath, wallboard, sheathing, tile, base-coat plasters, ready-mixed and other special-use plasters, and pulverized gypsum. The main markets were in the building industry, cement manufacture, agriculture, and as a filler. Minor markets were the glass and pottery industry and concerns having miscellaneous molding requirements. Unit value of crude gypsum was $4.42 per ton, compared with $4.23 per ton in 1962.

Lime.—The only commercial producer of quicklime and hydrated lime was Linwood Stone Products Co., Inc., with a plant near Buffalo, Scott County. American Crystal Sugar Co., Mason City, Cerro Gordo County, produced quicklime for internal use in sugar refining. Sales of quicklime and hydrated lime showed a marked increase in quantity and value in 1963.

High calcium limestone was used by both companies. Linwood Stone Products Co., Inc., used a rotary kiln and a continuous hydrator. American Crystal Sugar Co. used a shaft kiln. Fuels used were natural gas, bituminuous coal, and coke.

Principal uses were for water purification, steel (basic oxygen converter and open-hearth furnaces), sugar refining, and sewage treatment. The market area was Illinois, Iowa, and adjacent States.

Perlite.—Producers of gypsum products expanded crude perlite purchased from producers in Colorado and New Mexico. The expanded product was used for lightweight plaster aggregate. The major market was Iowa and adjacent States.

Sand and Gravel.—Production and total value of sand and gravel increased 3 percent over that of 1962. Commercial sales of sand and gravel decreased 11 percent in quantity for building construction, but paving uses increased 9 percent, paralleling the continued high demand for use in highway work. Production of sand and gravel by Government-and-contractor producers increased in 1963. Overall average unit values for all uses increased slightly in 1963.

Production of industrial sand (unground) increased substantially over that of 1962, but average unit value decreased. Uses included molding sand, blast sand, engine sand, and filter sand. All of the molding sand was produced from a friable sandstone deposit in Clayton County.

TABLE 5.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	2,340	$2,095	2,231	$2,061
Paving [1]	1,524	1,310	2,089	2,019
Fill	461	249	680	391
Undistributed [2]	231	596	207	594
Total	4,556	4,250	5,207	5,065
Gravel:				
Building	1,556	2,335	1,247	1,940
Paving [1]	4,618	4,033	4,616	3,932
Fill	209	126	115	78
Undistributed [3]	169	288	87	79
Total	[4] 6,551	[4] 6,783	[4] 6,066	[4] 6,030
Total sand and gravel	[4] 11,108	11,033	[4] 11,272	11,095
Government-and-contractor operations:				
Sand:				
Paving	39	21	221	121
Fill	9	5	10	7
Other	13	6	----	----
Total	61	[4] 31	[4] 230	[4] 129
Gravel:				
Building	----	----	16	9
Paving	2,555	1,383	2,635	1,609
Fill	2	1	----	----
Other	71	27	14	4
Total	[4] 2,629	[4] 1,410	2,665	[4] 1,621
Total sand and gravel	2,690	1,441	2,895	1,750
All operations:				
Sand	4,617	4,281	5,437	[4] 5,193
Gravel	9,180	8,193	[4] 8,730	[4] 7,652
Grand total	13,797	12,474	[4] 14,168	12,845

[1] Includes materials for bridges, culverts, and other uses.
[2] Includes blast, engine, filtration, molding, railroad ballast, and other construction and industrial sands.
[3] Includes gravel for railroad ballast and other uses.
[4] Data do not add to total shown because of rounding.

Seven percent of the total sand and gravel production was sold as unprocessed material. Commercially produced sand and gravel was transported mainly by truck.

The 10 leading producers, several operating in 2 or more areas of the State, in alphabetical order, were:

Acme Fuel & Material Co.
Concrete Materials Division, Martin Marietta Corp.
L. G. Everist, Inc.
Hallett Construction Co.
Keefner-White Materials Corp.
Maudlin Construction Co.
Mauer Construction Co.
Peters Construction Co.
Stevens Sand & Gravel, Inc.
Van Dusseldorp Construction Co.

Stone.—Overall production of stone, consisting entirely of limestone, was about 3 percent lower in quantity and 2 percent lower in total value than in 1962. Most of this decrease was crushed limestone and could be attributed to changes in use of road-base materials in some areas in the State.

Limestone was the leading raw mineral commodity; production was reported from 65 of 99 counties in the State.

Concrete aggregate and roadstone accounted for about 74 percent of the total limestone output. Cement manufacture accounted for 16 percent of the total and agricultural limestone consumption accounted for 7 percent. All other uses accounted for the remaining 3 percent.

Dimension limestone quarries were operated in Dubuque, Jones, and Delaware Counties. The Becker Stone Quarry near Dubuque and

TABLE 6.—Limestone sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rubble—thousand short tons	4	$33	2	$15
Rough architectural—thousand cubic feet			5	20
Sawed stone [1]—do	4	12	5	20
House stone veneer—do	7	23	14	22
Cut—do	42	69	53	71
Flagging—do	2	3	2	3
Total—approximate thousand short tons [2]	9	[3] 139	8	151
Crushed and broken:				
Riprap—thousand short tons	378	535	330	414
Concrete aggregate and roadstone—do	16,618	21,321	15,529	20,425
Agriculture—do	1,135	1,582	1,449	2,042
Railroad ballast—do	25	32	17	23
Cement—do	3,138	3,601	3,319	3,850
Undistributed [4]—do	315	1,034	251	883
Total—do	21,609	28,105	[3] 20,896	27,637
Grand total—do	21,618	28,244	20,904	27,788

[1] Excludes house stone veneer.
[2] Average weight of 170 pounds per cubic foot used to convert cubic feet to short tons.
[3] Data do not add to total shown because of rounding.
[4] Includes limestone for filter beds (1962), flux, lime, asphalt filler, fertilizer, mineral food, chemical, and other uses.

William C. Weber Stone Co. near Anamosa reported production of sawed stone, house stone veneer, cut stone, rough architectural stone, flagging, and rubble.

Overall unit value of crushed stone increased to $1.33 per ton, compared with $1.31 per ton in 1962. Average unit values increased a few cents for most uses.

The five leading limestone producing counties listed in descending order of production were Madison, Scott, Cerro Gordo, Linn and Johnson.

The 10 leading producers of limestone, listed alphabetically, were:

B. L. Anderson, Inc.
Concrete Materials Division, Martin Marietta Corp.
Dewey Portland Cement Co.
Kaser Construction Co.
Lehigh Portland Cement Co.
Marquette Cement Manufacturing Co.
Northwestern States Portland Cement Co.
Schildberg Construction Co., Inc.
The River Products Co.
Weaver Construction Co.

MINERAL FUELS

Coal (Bituminous).—Production and value of coal increased substantially for the 2d consecutive year. The 1963 output was 1.2 million tons, an increase of 7 percent from 1962. Virtually all of the coal produced was consumed within the State in electric powerplants and in heating public buildings. About 72 percent of the coal was transported by rail and the remainder by truck. Marion County accounted for 54 percent of the total coal output of the State. The average price of coal was $3.50 per ton, compared with $3.56 per ton in 1962. The average price of coal from deep mines was $4.22, and the average price of coal from strip mines was $3.39 per ton.

Production came from 13 underground mines and 19 strip mines, compared with 13 underground mines and 22 strip mines in 1962. Thickness of the coal seams mined in strip mines ranged from 22 to 72 inches and overburden ranged from 14 to 70 feet. In underground mining, the coal seams ranged from 29 to 66 inches. No mechanical cleaning plants were operated in the State.

Wilkinson Coal Co., Marion County, ceased operations late in 1963.

Peat.—Colby Pioneer Peat Co. and Eli Colby Co. produced peat in Worth and Winnebago Counties, respectively. Moss, reed-sedge, and humus were produced. Both companies operated processing plants in Hanlontown.

Petroleum.—Initial production of oil in Iowa was recorded as a result of a chance discovery near Keota, in Washington County. The Natural Gas Pipeline Co. of America tapped a deposit of crude oil while drilling for a prospective underground storage reservoir for natural gas. The strike was on the northeastern edge of the Forest City basin, approximately 90 miles northwest from a producing field in the Illinois basin. The producing horizon was the Pecatonica, of the lower Platteville formation of the Ordovician System. The well, designated W. F. Flynn P–1, was completed to a depth of

TABLE 7.—Coal (bituminous) production in 1963, by counties

(Excludes mines producing less than 1,000 tons)

County	Number of mines operated		Production (short tons)			Value
	Underground	Strip	Underground	Strip	Total	
Appanoose	8	----	36,751	----	36,751	$212,859
Lucas	1	----	46,807	----	46,807	194,602
Mahaska	----	6	----	331,349	331,349	1,099,359
Marion	3	7	64,264	595,053	659,317	2,235,999
Monroe	1	3	9,016	43,416	52,432	174,705
Van Buren	----	1	----	18,554	18,554	89,711
Wapello	----	2	----	67,779	67,779	237,004
Total	13	19	156,838	1,056,151	1,212,989	4,244,239

999 feet on February 25. Pumping commenced late in April and continued until November 1, when it was shut down. During the period March–October, 404 barrels of oil were produced.

REVIEW BY COUNTIES

Mineral production was reported from all counties except Davis, Ringgold, and Wayne. Some sand and gravel or limestone may have been produced in these counties, because several companies reporting production of these materials did not submit a breakdown showing output by county origin. Data covered production of commerical and Government-and-contractor producers of sand and gravel and limestone.

Some counties are not included in the county review section. However, all producing counties, as well as the minerals produced are listed in table 8.

Adair.—Schildberg Construction., Inc., produced limestone from three portable plants near Greenfield. Production was mainly used for highway construction and agricultural uses.

Allamakee.—Limestone was produced by three companies from portable plants; sand and gravel by two companies from stationary plants. The limestone was used mainly for roadstone and agricultural uses, the sand and gravel for building construction.

Appanoose.—Limestone was produced from portable and stationary plants by W. P. Farnsworth, L. & W. Construction Co., Inc., and Porter & Magnall Construction Co. for highway construction and agricultural purposes. Bituminous coal was produced at eight underground mines. Operating companies were Appanoose Coal Co., Clarke Coal Co., D. C. Coal Co., New Block Coal Co., New Gladstone Coal Co., Number 4 Coal Co., Riverside Coal Co., and Shamrock Coal Co. Riverside Coal Co. operated only during the first quarter of 1963.

The Carter-Waters Corp. produced lightweight aggregate (expanded shale) by the rotary-kiln method from a plant near Centerville. Adel Clay Products Co. of Centerville produced brick and other heavy clay products from a shale mined in the northern environs of Centerville.

TABLE 8.—Value of mineral production in Iowa, by counties [1]

County	1962	1963	Minerals produced in 1963 in order of value
Adair	(2)	(2)	Stone.
Adams	(2)	(2)	Do.
Allamakee	(2)	(2)	Stone, sand and gravel.
Appanoose	$958,242	$1,026,673	Stone, clays, coal.
Audubon		(2)	Sand and gravel.
Benton	(2)	(2)	Sand and gravel, stone, clays.
Black Hawk	1,219,599	1,277,605	Stone, sand and gravel.
Boone	(2)	393,515	Sand and gravel, clays.
Bremer	3,610	(2)	Stone, sand and gravel.
Buchanan	(2)	221,186	Do.
Buena Vista	197,328	165,406	Sand and gravel.
Butler	346,879	375,145	Stone, sand and gravel.
Calhoun	87,667	43,642	Sand and gravel.
Carroll	188,688	52,704	Do.
Cass	(2)	(2)	Stone, sand and gravel.
Cedar	271,229	(2)	Stone.
Cerro Gordo	24,582,656	24,837,004	Cement, stone, clays, lime, sand and gravel.
Cherokee	257,817	328,180	Sand and gravel.
Chickasaw	(2)	(2)	Stone, sand and gravel.
Clarke	(2)	(2)	Stone.
Clay	154,152	93,465	Sand and gravel.
Clayton	528,111	579,674	Sand and gravel, stone.
Clinton	(2)	(2)	Stone, sand and gravel.
Crawford	(2)	(2)	Sand and gravel.
Dallas	319,893	398,828	Sand and gravel, clays, stone.
Davis	(2)		
Decatur	(2)	(2)	Stone.
Delaware	248,067	276,593	Stone, sand and gravel.
Des Moines	1,271,548	1,390,222	Gypsum, stone, sand and gravel.
Dickinson	(2)	(2)	Sand and gravel.
Dubuque	458,365	524,974	Stone, sand and gravel.
Emmet	154,651	198,164	Sand and gravel.
Fayette	548,104	528,039	Stone, sand and gravel.
Floyd	332,666	337,978	Stone, clays, sand and gravel.
Franklin	287,126	244,057	Sand and gravel, clays, stone.
Fremont	63,551	90,326	Stone.
Greene	(2)	(2)	Sand and gravel.
Grundy	89,550	18,500	Sand and gravel, stone.
Guthrie	(2)	117,289	Sand and gravel.
Hamilton	161,292	(2)	Stone, sand and gravel.
Hancock	283,555	284,972	Do.
Hardin	1,261,951	1,213,864	Do.
Harrison	(2)	(2)	Stone.
Henry	(2)	(2)	Stone, sand and gravel.
Howard	(2)	109,679	Do.
Humboldt	(2)	(2)	Do.
Ida		(2)	Sand and gravel.
Iowa	(2)	(2)	Do.
Jackson	159,360	241,356	Stone, sand and gravel.
Jasper	(2)	(2)	Sand and gravel, stone.
Jefferson	(2)	(2)	Stone.
Johnson	734,296	1,653,758	Stone, sand and gravel.
Jones	349,234	350,255	Do.
Keokuk	(2)	(2)	Stone, clays.
Kossuth	223,655	192,500	Sand and gravel.
Lee	(2)	(2)	Stone, sand and gravel.
Linn	2,051,158	1,991,045	Do.
Louisa	(2)	(2)	Do.
Lucas	179,670	194,602	Coal.
Lyon	175,650	174,291	Sand and gravel.
Madison	3,032,294	2,563,844	Stone, clays.
Mahaska	1,584,914	1,530,439	Coal, sand and gravel, stone, clays.
Marion	2,841,808	3,002,708	Coal, stone, sand and gravel, clays.
Marshall	(2)	(2)	Stone, sand and gravel.
Mills	225,155	(2)	Stone.
Mitchell	349,511	(2)	Stone, sand and gravel.
Monona	72,000	192,040	Sand and gravel.
Monroe	180,373	174,705	Coal.
Montgomery	(2)	(2)	Stone.
Muscatine	1,043,768	984,972	Sand and gravel, stone.
O'Brien	152,193	226,546	Sand and gravel.
Osceola	(2)	(2)	Do.
Page	(2)	(2)	Stone, sand and gravel.
Palo Alto	64,381	88,825	Sand and gravel.
Plymouth	(2)	(2)	Do.
Pocahontas	557,453	(2)	Stone, sand and gravel.
Polk	13,008,307	14,189,362	Cement, sand and gravel, clays.
Pottawattamie	(2)	(2)	Stone, sand and gravel.
Poweshiek	(2)	(2)	Stone.
Sac	460,105	506,188	Sand and gravel.

See footnotes at end of table.

TABLE 8.—Value of mineral production in Iowa, by counties [1]—Continued

County	1962	1963	Minerals produced in 1963 in order of value
Scott	$12,892,016	$12,618,889	Cement, stone, lime, clays, sand and gravel.
Shelby	(2)	(2)	Sand and gravel.
Sioux	837,131	630,792	Do.
Story	618,392	(2)	Stone, sand and gravel, clays.
Tama	(2)	(2)	Sand and gravel, stone.
Taylor	(2)	(2)	Stone.
Union	(2)	(2)	Do.
Van Buren	1,027,527	824,398	Stone, sand and gravel, coal.
Wapello	643,792	497,587	Coal, sand and gravel, stone, clays.
Warren	87,500	(2)	Sand and gravel, clays.
Washington	(2)	(2)	Stone, petroleum.
Webster	5,247,338	5,489,353	Gypsum, stone, sand and gravel, clays.
Winnebago	(2)	274,512	Peat, sand and gravel.
Winneshiek	(2)	301,977	Stone, sand and gravel.
Woodbury	(2)	(2)	Sand and gravel.
Worth	(2)	405,014	Stone, peat, sand and gravel.
Wright	132,205	145,939	Sand and gravel.
Undistributed	13,352,831	13,096,419	
Total	96,561,000	97,670,000	

[1] Ringgold and Wayne Counties are not listed because no production was reported.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Black Hawk.—Concrete Materials Division, of Martin Marietta Corp., and DeWees & Pottoff Stone Co. produced limestone for road construction, agricultural uses, and riprap. Quarries were operated near Janesville, La Porte City, Raymond, and Waterloo.

Sand and gravel was produced by four companies and the Waterloo Street Department from stationary plants near Cedar Falls, La Porte City, and Waterloo. Some sand was contracted by the county highway department and used for paving and fill.

Boone.—Hallett Construction Co., Maudlin Construction Co., and Vanden Brink Bros. produced sand and gravel from portable and stationary plants for building construction, road paving, and fill from pits near Boone and Madrid. Grarok, Inc., processed clays for pozzolanic uses.

Butler.—Over 244,000 tons of limestone was produced from portable and stationary plants by seven companies. The limestone was used for road construction and agricultural uses. Nearly 123,000 tons of sand and gravel was produced by five companies for building construction, road paving, and fill.

Cass.—Schildberg Construction Co., Inc., produced limestone from quarries near Atlantic and Lewis. Output was for highway construction and agricultural uses. Warren Sand Pit operated a stationary plant near Atlantic and produced paving sand.

Cerro Gordo.—Mineral production from this county represented more than 25 percent of the State's total mineral value. Northwestern States Portland Cement Co. and Lehigh Portland Cement Co. operated plants near Mason City and manufactured portland and masonry cement, using locally produced limestone and clays. Mason City Brick & Tile Co. mined clay for the production of heavy clay products.

Grupp Construction Co., Ideal Sand & Gravel Co., Lehigh Portland Cement Co., Northwestern States Portland Cement Co., and Weaver Construction Co. operated stationary and portable plants near Mason City and Rock Falls. Production was used for cement

manufacturing, highway construction, agricultural uses, riprap, and miscellaneous filler. Total limestone production was over 1.6 million tons. Lime was produced for internal use by the American Crystal Sugar Co. Three companies operated stationary and portable plants near Clear Lake and Mason City, and produced 128,000 tons of sand and gravel for building construction and road paving. The county highway department contracted for 64,000 tons of paving gravel.

Clayton.—Over 141,000 tons of limestone was produced by four companies and used for road construction and agriculture. Concrete Materials Division, Martin Marietta Corp., mined a friable sandstone and processed it for use as molding sand.

Clinton.—Lowe & Eschman Construction Co. near DeWitt and Techau Limestone Co., Grand Mound operated portable plants and produced limestone for use in highway construction, agriculture, and riprap. Sand and gravel was produced by four companies from portable and stationary plants for building construction, paving, and fill. Plants were operated near Camanche, DeWitt, and Long Grove.

Dallas.—Adel Clay Products Co., Redfield Brick & Tile Co., and United Brick & Tile Co. of Iowa manufactured building brick and other heavy clay products from shales of their own production. Sand and gravel was produced by Adel Sand & Gravel Co., Booneville Gravel Co., and Perry Sand & Gravel Co. from stationary and portable plants near Adel, Booneville, and Perry, respectively. The material was used for building construction, paving, and fill. Gendler Stone Products Co. produced crushed limestone for highway construction from a portable plant near Dexter.

Des Moines.—Limestone was produced by two companies for use in highway construction, agriculture, and riprap. Spring Sand & Gravel Co. operated a stationary plant near Burlington and produced sand and gravel for building, paving, and fill.

United States Gypsum Co. operated an underground mine and a plant near Sperry. Products manufactured included wallboard, sheathing, plaster-base lath, and other building products.

Dubuque.—Becker Stone Quarry produced limestone for architectural purposes, rough construction, and riprap from a stationary plant near Dubuque. Dubuque Stone Products Co. and L. A. Light Construction Co. produced crushed limestone near Dubuque for road construction, agriculture, and riprap. The county highway department produced crushed limestone for road construction. Molo Sand & Gravel Co. operated a stationary plant near Dubuque and produced sand and gravel for building, paving, fill, and sand-blasting. The city of Dubuque contracted for paving sand.

Fayette.—Three companies and the county highway department produced crushed limestone for road construction and agricultural purposes. Sand and gravel was produced by two companies for building and road construction.

Floyd.—Five companies operated portable plants and produced a total of 197,309 tons of crushed limestone for road construction and agricultural uses. Rockford Brick & Tile Co. mined clay from a pit near Rockford for manufacturing heavy clay products. Heckman-Reynolds, Inc., operated a stationary plant near Floyd and produced sand and gravel for building and road construction. Floyd County

Highway Department and Cerro Gordo County Highway Department contracted for 21,000 tons of sand and gravel for road paving.

Franklin.—Sheffield Brick & Tile Co. produced clay near Sheffield for manufacturing heavy clay products. Sand and gravel was produced by four companies and the county highway department for building, road construction, railroad ballast, and other uses. Total production was over 240,000 tons. Limestone was produced by three companies operating portable and stationary plants for road construction and agricultural uses.

Hardin.—Over 415,000 tons of sand and gravel was produced by six companies and contracted for by the county highway department. Production was from stationary and portable plants. Pits were operated near Eldora, Iowa Falls, Alden, and Gifford. The material was chiefly used for building and road construction. Limestone was produced by Iowa Limestone Co. and Weaver Construction Co. which operated stationary and portable plants near Alden. Production was mainly for road construction and agriculture uses.

Jasper.—Kaser Construction Co. produced crushed limestone and sand from separate operations near Sully, chiefly for road construction. Van Dusseldorp Construction Co. produced 194,000 tons of sand and gravel from a stationary plant near Colfax for building, road construction, and fill. The county highway department contracted for paving gravel.

Johnson.—Concrete Materials Division, Martin Marietta Corp.; The River Products Co.; and Weaver Construction Co. produced crushed limestone from portable plants for use chiefly in building, road construction, and agriculture. Stevens Sand and Gravel Co., Inc., produced sand and gravel from a portable plant near Iowa City for building and road construction.

Keokuk.—Limestone for highway and agricultural purposes was produced by Kaser Construction Co. Nelson Clay Products Co. and Oskaloosa Clay Products Co., near What Cheer, mined shale chiefly for use in manufacturing heavy clay products.

Lee.—Limestone was produced by Peter H. Beach and Raid Quarries, Inc., from stationary and portable plants for road building, railroad ballast, and agricultural use. The county highway department contracted for sand and gravel for road paving.

Linn.—Nearly $2 million worth of limestone and sand and gravel was produced in the county. B. L. Anderson, Inc., Concrete Materials Division, Martin Marietta Corp.; L. Crawford Lime & Quarry Co.; DeWees & Pottoff Stone Co.; and G. W. Gaines & Son produced limestone from portable and stationary plants from quarries operated near Cedar Rapids, Marion, and Mt. Vernon. Production was used for highway construction, agriculture, and riprap. Sand and gravel was produced by four companies, all operating stationary plants, and used for building and road construction.

Lucas.—Big Ben Coal Co. produced nearly 47,000 tons of coal from an underground mine near Chariton.

Madison.—Nearly 1.8 million tons of limestone was quarried by six companies and the county highway department. Penn-Dixie Cement Corp. and Marquette Cement Manufacturing Co. were two of the chief producers. Output from their quarries was used in the manufacture of portland cement. Substantial tonnage of crushed lime-

stone also was produced for concrete aggregate, road construction, and agricultural limestone. Clay was mined by Marquette Cement Manufacturing Co. from a pit near Earlham for use in its cement plant in Polk County.

Mahaska.—Angus Coal & Hauling Co., De Long Coal Co., Lost Creek Coal Co., Mich Coal Co., and Star Coal Co. produced bituminous coal from six strip mines.

Limestone was produced near Oskaloosa by Kaser Construction Co. for highway construction and agricultural purposes. Griffin Pipe Products Co. and Oskaloosa Clay Products Co. mined shale from pits near Rose Hill and Eddyville, respectively. The material was used for manufacturing building brick and sewer pipe. Concrete Materials Division, Martin Marietta Corp. produced sand and gravel for building and road paving.

Marion.—Over 54 percent of the bituminous coal produced in Iowa came from mines in Marion County. Strip mine producers were Beard Coal Co., Hopkins Coal Co., Jude Coal Co., Inc., Newton Coal Co., Ver Steeg Coal Co., Weldon Coal Co., and Wilkinson Coal Co. Underground producers were Good Coal Co., Lovilia Coal Co., and Walter Coal Co.

Three companies produced crushed limestone for road construction and agricultural use. Quarries were operated near Harvey, Lacona, and Pella. Three companies produced sand and gravel from portable and stationary plants near Harvey, Knoxville, and Pella for building and road construction. The county highway department contracted for paving sand. Shale was removed as overburden from the Ver Steeg Coal Co. mine near Knoxville and sold for use in manufacturing heavy clay products.

Marshall.—Approximately 374,000 tons of sand and gravel was produced by three companies and under contract for the county highway department from stationary and portable plants. Output was for building and road construction. Limestone was quarried by Concrete Materials Division, Martin Marietta Corp., near Ferguson and Le Grand for highway construction and agricultural uses.

Monroe.—Over 52,000 tons of bituminous coal was produced by Acme Coal Co., which operated an underground mine near Lovilia. De Long Coal Co., Corwin Hatch, and Weldon Coal Co. operated strip mines near Beacon, Knoxville, and Lovilia.

Muscatine.—Acme Fuel & Material Co., Hahn Brothers Sand & Gravel Co., Northern Gravel Co., Harold F. Storm, and Wendling Quarries, Inc., produced a total of 519,000 tons of sand and gravel. Production was from stationary and portable plants and used chiefly for building and road construction. Wendling Quarries, Inc., also quarried limestone for road construction, agricultural purposes, and riprap

Polk.—The county was second in the State in value of minerals produced with a value of over $14 million. Marquette Cement Manufacturing Co. and Penn-Dixie Cement Corp. operated cement plants, producing portland cement types I, II, and III. Marquette Cement Manufacturing Co. also produced masonry cement. Clay and limestone used by these companies were produced in Madison County. Des Moines Clay Co., Goodwin Tile & Brick Co., and Iowa Clay Pipe Co. mined shale and manufactured building brick and other heavy

clay products. Sand and gravel was produced by seven companies principally for highway and building construction.

Scott.—The county ranked third in mineral production in the State. Linwood Stone Products Co., Inc., produced quicklime and hydrated lime at its plant near Buffalo. It was the only commercial producer of lime in the State. The products were sold chiefly for chemical and metallurgical uses. Dewey Portland Cement Co., with a plant near Davenport, produced types I, II, and III portland cement and masonry cement using clay and limestone from nearby company-owned sources. Crushed limestone also was produced by Le Claire Quarries, Inc., Linwood Stone Products Co., Inc., and Weaver Construction Co. Production was mainly used for highway construction. Sand was produced by Builders Sand & Gravel Co. from a stationary plant near Princeton for building construction.

Story.—Nevada Brick & Tile Co. mined shale from a pit near Nevada for manufacturing heavy clay products. Limestone was quarried by Ray Cook Construction Co., Inc., and Weaver Construction Co. from quarries near Ames and Roland, respectively, and was used for highway construction and agriculture. Sand and gravel was produced by Ray Cook Construction Co., Inc., Hallett Construction Co., and Maudlin Construction Co. from pits near Ames. Chief uses were for building and road construction.

Van Buren.—Douds Stone, Inc., operated an underground limestone mine near Douds. Limestone also was produced by Kaser Construction Co., Triangle Quarries, Inc., and the county highway department. Uses were for road construction and agriculture.

Laddsdale Coal Co., Inc., produced nearly 19,000 tons of bituminous coal from a strip mine near Eldon.

Sand and gravel used for building and road paving was produced by Valley Limestone & Gravel, Inc., and Raid Quarries, Inc., from stationary and portable plants near Farmington.

Wapello.—New Lanning Coal Co., Inc., and South Iowa Coal Co. produced bituminous coal from strip mines near Kirkville and Eddyville, respectively. Ottumwa Brick & Tile Co. and Oskaloosa Clay Products Co. mined shale for manufacturing building brick and other heavy clay products. Wapello Stone Quarries operated a portable plant near Ottumwa and produced limestone for highway construction, agricultural uses, and riprap. Concrete Materials Division, Martin Marietta Corp., operated a stationary plant near Ottumwa and produced sand and gravel for building and road construction.

Washington.—Oil was discovered near Keota when the Natural Gas Pipeline Co. of America by chance tapped a deposit of crude oil while drilling to locate an underground gas storage reservoir. The well, located in Sec. 20, T 76 N, R 9 W on the William Flynn property and designated W. F. Flynn P–1, was completed to a depth of 999 feet on February 25. Approximately 400 barrels of oil were produced during the period March–October. Pumping at the well was discontinued November 1, and no further production was recorded.

Crushed limestone was produced by Kaser Construction Co. from the Coppock and West Chester quarries and The River Products Co. (formerly Dillon Stone Co.), operating the Grace Hill and Keota open quarries and the Young America underground mine. Output was for roadstone and agricultural limestone.

Webster.—Gypsum was mined, processed, and fabricated by Bestwall Gypsum Co., The Celotex Corp., National Gypsum Co., and United States Gypsum Co. Mining was by open-pit methods.

Limestone was produced from an underground mine by Fort Dodge Limestone Co., Inc. Northwest Limestone Co. also produced crushed limestone. All stone was used for highway construction and agricultural purposes. Sand and gravel was produced by Welp & McCarten, Inc., from seven pits, and by Maudlin Construction Co. and the county highway department for use as road paving.

Lehigh Sewer Pipe & Tile Co., Kalo Brick & Tile Co., Johnston Clay Works, Inc., and Vincent Clay Products Co. mined clay. Manufactured products include building brick, building tile, sewer pipe, and other heavy clay products.

Winnebago and Worth Counties.—Eli Colby Co. and Colby Pioneer Peat Co. produced moss, reed-sedge, and humus peat. Peat was processed in plants near Hanlontown. Limestone and sand and gravel were produced in Worth County and sand and gravel was produced in Winnebago.

The Mineral Industry of Kansas

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the State Geological Survey of Kansas for collecting information on all minerals except fuels.

By W. G. Diamond,[1] P. L. Hilpman,[2] A. L. Hornbaker,[2] and R. G. Hardy[2]

THE mineral industry of Kansas set a new record high in 1963; mineral production was valued at $518 million, compared with the previous record—$514 million in 1957. Of the 14 mineral commodities produced in Kansas, all except petroleum and zinc increased in value of production. Principal mineral commodities in order of value were petroleum, natural gas, cement, natural gas liquids, and stone. Mineral output was reported from all 105 counties. Mineral fuels and related products comprised 86.3 percent of the total value, nonmetals 13.5 percent, and metals 0.2 percent.

TABLE 1.—Mineral production in Kansas[1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	8,058	$25,134	8,201	$25,372
Masonry—thousand 280-pound barrels	392	1,156	387	1,183
Clays—thousand short tons	895	1,091	893	1,104
Coal—do	915	4,249	1,169	5,311
Helium—thousand cubic feet	42,305	1,478	[2] 46,177	[2] 1,616
Lead (recoverable content of ores, etc.)—short tons	970	178	1,027	222
Lime—thousand short tons	5	59		
Natural gas—million cubic feet	694,352	86,100	732,946	97,482
Natural gas liquids:				
Natural gasoline—thousand gallons	151,360	7,696	165,370	9,811
LP gases—do	166,769	6,295	395,877	15,481
Petroleum (crude)—thousand 42-gallon barrels	112,076	326,141	[3] 109,107	[3] 317,501
Salt[4]—thousand short tons	944	11,654	924	11,993
Sand and gravel—do	11,552	8,039	12,062	8,676
Stone—do	[5] 13,527	[5] 17,274	13,558	18,483
Zinc (recoverable content of ores, etc.)—short tons	3,943	907	3,508	807
Value of items that cannot be disclosed: Natural cement, gypsum, pumice, salt (brine), and stone (crushed sandstone, 1962)		3,625		3,260
Total		501,076		518,302

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Does not include 740,880,000 cubic feet of crude helium valued at $8,472,000 shipped to underground storage at Amarillo, Tex.
[3] Preliminary figure.
[4] Excludes salt in brine included with "Value of items that cannot be disclosed."
[5] Excludes certain stone included with "Value of items that cannot be disclosed."

[1] Economist, U.S. Bureau of Mines, Bartlesville, Okla.
[2] Geologist, State Geological Survey of Kansas, The University of Kansas, Lawrence, Kans.

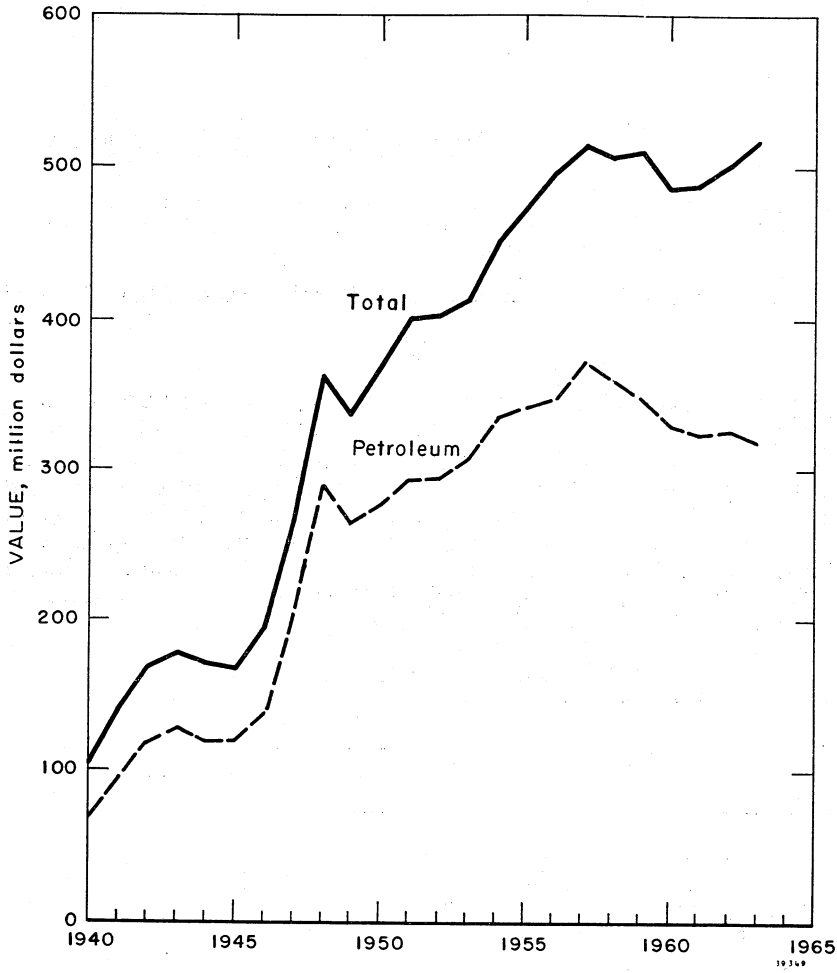


FIGURE 1.—Value of petroleum, and total value of mineral production in Kansas, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Employment and Injuries.—According to the Employment Security Division of the Kansas Department of Labor, average annual employment in Kansas mining industries in 1963 was 15,100, compared with 15,700 in 1962. Mining employment decreased for the 4th consecutive year. Weekly earnings per person in the mining industries

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$485,726	1958	$506,328
1953	466,826	1959	515,810
1954	492,466	1960	486,388
1955	513,094	1961	483,304
1956	528,569	1962	489,677
1957	509,483	1963	506,669

averaged $108.62 compared with $106.30 in 1962. The average work week decreased from 49.6 hours in 1962 to 42.1 hours in 1963.

According to the Workmen's Compensation Commission, State of Kansas, 1,206 on-the-job injuries occurred in the mining industries in 1963. Thirteen injuries were fatal; 12 fatalities occurred in oil and gas well drilling and 1 in nonmetallic mining and quarrying.

TABLE 3.—Average annual employment for selected mineral industries

Industry	1954–58 (average)	1959	1960	1961	1962	1963
Mining (total)	18,680	18,300	16,900	16,200	15,700	15,100
Metal mining	300	(1)	(1)	(1)	100	100
Mining and quarrying of nonmetallic metals, except fuels	1,800	1,900	1,700	1,600	1,500	1,500
Bituminous coal and lignite mining	400	300	300	300	300	300
Crude petroleum and natural gas	16,080	16,100	14,900	14,300	13,800	13,200
Petroleum refining and related industries	4,900	4,900	4,700	4,600	4,500	4,400

[1] Employment estimated to be less than 100.

Source: Employment Security Division, Kansas Department of Labor.

Legislation and Government Programs.—The U.S. Supreme Court struck down a Kansas requirement that interstate pipeline companies buy natural gas at a uniform rate from all wells in the same reservoir to which their pipes were connected.

The new area price method was upheld, in which the Federal Power Commission would set a guide price for all natural gas produced in a particular field. Adjustments could be made if evidence indicated the price was unfair to producers or consumers.

The Kansas Supreme Court ruled that Kansas Corporation Commission may continue consideration of factors other than purchaser nominations in setting gas allowables.

The Kansas Legislature passed House Bill 403, The Water Plan Act, which provides for development of a State water plan, State financial assistance to public corporations (primarily watershed districts) for part of the cost of flood control storage, and for State financial participation in the storage of water in Federal water projects.

According to the Kansas Highway Commission, highway construction contracts approved during the year totaled $71.4 million. Projects authorized included construction of 690 miles of roads, 135 bridges, and 1,800 miles of resurfacing maintenance on State and interstate routes. Also 787 miles of road improvement and 106 bridges on secondary county roads were authorized. An additional 420 miles of State and interstate highways were opened to traffic during 1963.

Since enactment of the Federal Highway Act in 1956, $205.5 million has been allocated to Kansas. Of this amount, $18.6 million had not been obligated at yearend.

Water.—Water problems including long-range supply, quality, pollution, reuse, and treatment received increasing attention from Federal and State agencies and private research institutions. The Federal Bureau of Mines conducted a nationwide canvass of the mineral industry in 1963 to obtain 1962 water use data. The following tables are based on results of the survey.

TABLE 4.—Water use in the mineral industry in 1962

(Million gallons)

	New water	Water recirculated	Total water use	Water discharged	Water consumed
Quarries and mills	404	197	601	284	120
Coal (bituminous)	147	1,715	1,862	46	101
Metal mines and mills	61	60	121	30	31
Nonmetal mines and mills	4,018	771	4,789	3,939	80
Sand and gravel mines	8,760	2,540	11,300	8,666	94
Natural gas processing plants	668	26,553	27,221	238	430
Petroleum	6,299	7,912	14,211	32	6,267
Total	20,357	39,748	60,105	13,235	7,123

TABLE 5.—Water usage of wells drilled by rotary tools, by county, in 1962

(Barrels)

County	Number of wells	Total footage	Fresh water used	Saline water used	Total barrels/foot
Allen	141	118,365	63,000	63,000	1.06
Anderson	29	23,245	6,000	6,000	.52
Barber	57	270,675	503,600		1.86
Barton	185	636,431	565,053	51,427	.97
Bourbon	12	7,563	1,258	1,000	.30
Butler	150	401,705	410,306		1.02
Chase	10	18,415	9,600		.52
Chautauqua	11	29,075	17,850		.61
Cheyenne	7	35,825	43,000		1.20
Clark	20	111,768	127,100		1.14
Clay	3	6,735	1,600	1,750	.50
Comanche	19	98,658	138,093		1.40
Cowley	127	354,443	118,950		.30
Decatur	38	143,182	194,400		1.36
Dickinson	3	7,721	7,700		1.00
Edwards	36	161,729	259,800		1.61
Elk	3	5,590	7,200		1.29
Ellis	173	625,312	497,800	9,969	.81
Ellsworth	16	52,660	35,650		.68
Finney	43	180,591	307,379		1.70
Ford	8	35,686	53,500		1.50
Geary	4	8,418	8,400		1.00
Gove	9	39,330	55,050		1.40
Graham	99	389,619	523,219		1.34
Grant	10	40,737	70,301		1.73
Gray	2	8,912	11,300		1.27
Greenwood	114	240,030	199,550		.83
Hamilton	25	75,781	136,400		1.80
Harper	22	104,732	104,600	2,000	1.02
Harvey	46	136,934	104,472		.76
Haskell	55	288,861	363,974		1.26
Hodgeman	82	378,875	641,690		1.69
Kearny	4	15,597	27,739		1.78
Kingman	104	446,386	486,550		1.09
Kiowa	31	150,926	180,882		1.20
Lane	14	64,816	94,700		1.46
Lincoln	1	3,827	2,800		.73
Logan	7	33,903	50,850		1.50
Lyon	1	1,903	500		.26

TABLE 5.—Water usage of wells drilled by rotary tools, by county, in 1962—Continued

(Barrels)

County	Number of wells	Total footage	Fresh water used	Saline water used	Total barrels/foot
McPherson	80	250,648	288,988		1.15
Marion	143	358,662	284,097		.79
Meade	22	120,862	187,300		1.55
Montgomery	3	3,500	1,900		.54
Morton	58	284,484	426,600		1.50
Nemaha	1	3,951	750		.19
Ness	75	330,168	494,150	28,000	1.58
Norton	26	96,825	145,850		1.51
Osborne	1	3,900	3,800		.97
Pawnee	26	100,993	56,500	3,500	.59
Phillips	3	10,525	3,290		.31
Pratt	58	256,123	178,150		.70
Rawlins	17	76,822	76,150		.99
Reno	53	199,924	169,600	300	.85
Rice	160	542,816	410,560	1,000	.76
Riley	1	1,125	500		.44
Rooks	117	411,622	392,460	20,060	1.00
Rush	69	257,639	305,373	20,880	1.27
Russell	163	431,988	229,050	126,061	.82
Saline	46	144,379	158,055		1.09
Scott	4	15,896	25,400		1.60
Sedgwick	56	175,812	121,323		.69
Seward	66	392,400	709,840		1.81
Sheridan	13	51,811	72,500		1.40
Sherman	2	9,198	11,100		1.21
Stafford	172	684,876	688,748	49,196	1.08
Stanton	12	67,801	108,500		1.60
Stevens	25	152,180	319,839		2.10
Sumner	62	236,446	137,650		.58
Thomas	2	9,741	14,600		1.50
Trego	49	191,590	189,700		.99
Wabaunsee	1	3,370	750		.22
Wallace	4	21,550	32,300		1.50
Wichita	6	31,233	46,850		1.50
Woodson	1	1,734	500		.29
Total	3,318	11,687,555	12,724,539	384,143	1.12

TABLE 6.—Water usage of wells drilled by cable tools, by county, in 1962

(Barrels)

County	Number of wells	Total footage	Fresh water used	Saline water used	Total barrels/foot
Allen	2	1,600	25		0.02
Chautauqua	2	2,600	3,500		1.35
Crawford	37	15,476	11,500		.74
Decatur	2	8,565	9,000		1.05
Douglas	12	10,712	2,700	2,650	.50
Elk	11	12,407	4,200		.34
Franklin	42	32,969	8,400	5,000	.41
Jackson	1	3,450	1,050	1,050	.61
Johnson	11	9,335	4,600		.49
Labette	18	13,133	4,000	2,600	.50
Leavenworth	1	690	300		.43
Linn	17	9,178	2,750		.30
Lyon	8	19,763	5,930		.30
Miami	66	31,955	12,800		.40
Montgomery	168	145,699	43,700	29,100	.50
Morris	4	9,445	2,350	2,350	.50
Neosho	78	56,533	24,050	3,900	.49
Phillips	22	42,849	17,200		.40
Rawlins	2	9,230	10,000		1.08
Rice	1	1,200	400		.33
Riley	8	11,486	5,150		.45
Russell	4	12,000	800		.07
Stafford	12	20,000	2,400		.12
Wabaunsee	1	2,435	900		.37
Wilson	125	116,753	45,000	7,500	.45
Woodson	7	10,392	3,100		.30
Total	662	609,855	225,805	54,150	.46

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Total value of mineral fuels produced in 1963 was $447 million, $15 million more than that in 1962. Coal, helium, natural gas, and natural gas liquids increased in output and value, and petroleum decreased.

Carbon Black.—Carbon black output decreased 39 percent in volume and 44 percent in value. Principal reason for the decline was the closing of the United Carbon plant at Ryus in Grant County. Natural gas and natural gas liquids were used as feedstock at Columbian Carbon Co. plant at Hickok in Grant County.

TABLE 7.—Carbon black production

	1960	1961	1962	1963
Carbon black produced, all grades.....pounds..	87,302,185	89,936,075	102,282,466	61,916,880
Value at plants.....	$5,621,236	$6,243,192	$7,118,849	$3,983,554
Natural gas processed.....thousand cubic feet..	3,914,444	3,645,118	3,564,057	2,545,182
LP gases and other liquid fuel processed.....barrels..	398,415	361,005	422,401	263,808

Source: Kansas Corporation Commission.

Coal (Bituminous).—Bituminous coal production in Kansas totaled 1,169,000 tons, exceeding 1 million tons for the first time since 1954. Coal was mined in six counties, and output of 1,000 tons or more was reported from nine strip mines and one underground mine; five strip mines and one underground mine in Crawford, Linn, and Osage Counties produced less than 1,000 tons each. Overburden excavated at strip mines in 1963 totaled 30 million cubic yards, an average of nearly 26 cubic yards for each ton of coal strip-mined. Over 97 percent of total coal mined was mechanically cleaned at four cleaning plants; over 65 percent was crushed at four mines. Coal shipments were 77 percent by rail and 23 percent by truck.

TABLE 8.—Coal (bituminous) production

(Excludes mines producing less than 1,000 short tons)

Year	Number of mines			Short tons (thousands)	Value (thousands)
	Underground	Strip	Total		
1954–58 (average).....	----	----	----	914	$3,933
1959.....	2	11	13	772	3,607
1960.....	2	11	13	888	4,197
1961.....	1	9	10	664	3,102
1962.....	1	10	11	915	4,249
1963.....	1	9	10	1,169	5,311

Helium.—By the end of July, three private helium plants—constructed to implement the long-range helium-conservation program—were delivering crude helium to the Bureau of Mines for storage in the Cliffside gasfield at Amarillo, Tex. Helium was extracted from natural gas enroute to fuel markets and transported in the Bureau of Mines pipeline system. Initial delivery from the Northern Helex Co. plant near Bushton in Ellsworth County was made in December 1962;

annual capacity of the plant was 700 million cubic feet. Cities Service Helex, Inc., made initial delivery from its plant near Ulysses in Grant County in June 1963; annual capacity of the plant was 600 million cubic feet. Initial delivery from National Helium Corp. plant near Liberal in Seward County was made in July 1963; part of the natural gas processed came from out-of-State. The plant had annual capacity of more than 1 billion cubic feet. Shipments from the three plants totaled 741 million cubic feet valued at $8.5 million.

Helium shipments from the Bureau of Mines helium plant at Otis in Rush County totaled 46 million cubic feet valued at $1.6 million, an increase of 9 percent in quantity and value over that of 1962. Shipments of helium with a purity of 99.995 percent or greater increased to meet demand in numerous phases of scientific research.

Natural Gas.—Marketed production of natural gas totaled 732,946 million cubic feet valued at $97.5 million, a record high in output and value. Natural gas was produced from 8,266 wells, compared with 7,000 wells in 1962. Kansas ranked fifth in marketed production. Hugoton gasfield area, comprising all or part of Finney, Grant, Hamilton, Haskell, Kearny, Morton, Seward, Stanton, and Stevens Counties, produced 76 percent of the State total.

Natural Gas Liquids.—Recovery of natural gas liquids increased 76 percent in volume and 81 percent in value over that of 1962. LP gases comprised 71 percent of total output and 61 percent of total value; recovery of LP gases increased 137 percent in volume and 146 percent in value over that of 1962. Natural gasoline supplied 29 percent of total volume and 39 percent of total value; recovery of natural gasoline increased 9 percent in volume and 27 percent in value.

TABLE 9.—Marketed production of natural gas

Year	Million cubic feet	Value (thousands)	Year	Million cubic feet	Value (thousands)
1954–58 (average)	511,601	$57,275	1961	649,083	$81,135
1959	604,410	72,529	1962	694,352	86,100
1960	634,410	74,226	1963	732,946	97,482

TABLE 10.—Marketed production of natural gas from the Kansas part of Hugoton gas area

Year	Million cubic feet	Year	Million cubic feet
1944	92,923	1954	346,732
1945	90,345	1955	394,257
1946	119,638	1956	381,875
1947	157,663	1957	396,889
1948	185,873	1958	349,264
1949	247,869	1959	404,764
1950	320,545	1960	451,820
1951	371,002	1961	467,842
1952	375,082	1962	518,069
1953	387,635	1963	556,067

Source: 1952–57 data from Oil and Gas Developments in Kansas during 1957. State Geol. Survey of Kansas, Univ. of Kansas Pub. Bull. 133, 1958, p. 33. 1958–63 data from Conservation Division, Kansas Corporation Commission.

TABLE 11.—Important gasfields discovered in 1963

(Thousand cubic feet per day)

Pool or field	County	Initial production	Pool or field	County	Initial production
DeGeer Southwest	Barber	18,400	Meyers	Meade	1,356
Groendycke	do	6,225	Eddy	Pawnee	2,310
Tuttle East	Comanche	2,630	Gereke West	Pratt	2,310
Bordewick	Edwards	1,600	Pratt Airport	do	3,000
Britton	do	5,087	Arkalon West	Seward	50,000
McClanahan East	do	2,478	March	do	1,100
Bucklin	Ford	2,000	Emerson West	Stafford	8,060
Nashville	Kingman	1,050	Gooch	Stevens	2,060
Ursula Northeast	Kiowa	2,422	Corastone	Sumner	2,800
Crooked Creek	Meade	1,100			

Source: State Geol. Survey of Kansas, Oil and Gas Developments in Kansas During 1963. Bull. 172 (advance).

TABLE 12.—Leading gasfields[1]

(Million cubic feet)

Field	County	Discovery date	Annual production			Cumulative production Dec. 31, 1963
			1961	1962	1963	
Hugoton Gas Area	(2)	1930	467,842	518,069	556,067	7,008,280
Greenwood Gas Area	Morton	1951	39,771	31,277	33,394	379,775
Medicine Lodge-Boggs	Barber	1927	5,058	5,150	6,140	273,569
Spivey-Grabs-Basil	Harper-Kingman	1949	24,953	28,353	30,811	153,359
Rhodes	Barber	1954	9,832	6,616	6,271	77,328
Hardtner	do	1954	6,340	5,061	5,361	75,218
McKinney	Clark-Meade	1950	7,804	7,166	7,356	60,365
Boggs Southwest	Barber	1955	3,207	2,686	1,922	44,967
Sparks	Morton-Stanton	1954	6,360	5,243	4,605	41,218
Glick	Commanche-Kiowa.	1957	10,396	10,959	14,160	35,590
Aetna Gas Area	Barber	1935	7,734	5,775	5,618	34,564
Taloga	Morton	1955	3,196	1,734	1,730	30,223
Richfield	do	1948	1,189	1,033	1,575	30,153

[1] Fields with cumulative production in excess of 30,000,000,000 cubic feet.
[2] Stevens, Grant, Kearny, Finney, Haskell, Morton, Seward, Stanton, and Hamilton Counties (in descending order of cumulative production).

Source: State Geological Survey of Kansas, Oil and Gas Developments in Kansas during 1963. Bull. 172 (advance).

TABLE 13.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	111,909	$6,067	98,093	$3,695	210,002	$9,762
1959	107,814	5,576	124,874	6,658	232,688	12,234
1960	115,868	6,694	127,270	6,343	243,138	13,037
1961	132,180	5,790	135,643	5,916	267,823	11,706
1962	151,360	7,696	166,769	6,295	318,129	13,991
1963	165,370	9,811	395,877	15,481	561,247	25,292

New facilities, especially those constructed in conjunction with helium extraction, greatly increased natural gas liquids capacity. New plants included Northern Gas Products Co. (subsidiary of Northern Natural Gas Co.) plant near Bushton in Ellsworth County, Kansas Hydrocarbons Co. (affiliated with Plateau Natural Gas Co.)

plants at Burrton in Harvey County and at Cheney in Kingman County, National Helium Corp. (Panhandle Eastern Pipe Line Co. and National Distillers & Chemical Corp.) plant near Liberal in Seward County, Cities Service Oil Co. fractionation plant at Hutchinson in Reno County, and Anadarko Production Co. (subsidiary of Panhandle Eastern Pipe Line Co.) plant near Liberal in Seward County. Panhandle Eastern Pipe Line Co. plant in Seward County was shut down during the year.

Petroleum.—Kansas ranked seventh in volume and sixth in value of petroleum production. Total production and value decreased 3 percent from that of 1962. Petroleum was produced from 46,951 wells.

Petroleum refineries operated at about 81 percent of capacity, compared with 83 percent in 1962. Daily crude capacity increased 210 barrels per stream day to a total of 367,475 barrels.[3]

TABLE 14.—Crude petroleum production

(Thousand barrels and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954–58 (average)	121,749	$350,877	1961	112,241	$324,376
1959	119,543	347,870	1962	112,076	326,141
1960	113,453	329,014	1963 [1]	109,107	317,501

[1] Preliminary figures.

TABLE 15.—Crude petroleum production, indicated demand and stocks in 1963 by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks originating in Kansas (end of month)	Month	Production	Indicated demand	Stocks originating in Kansas (end of month)
January	8,707	8,864	8,050	September	8,939	8,959	7,381
February	8,765	9,267	7,548	October	9,371	8,366	8,386
March	9,386	9,575	7,359	November	8,890	8,469	8,807
April	9,253	8,735	7,877	December	9,059	10,295	7,571
May	9,163	8,290	8,750				
June	8,993	9,229	8,514	Total:			
July	9,342	10,095	7,761	1963 [1]	109,107	109,743	----------
August	9,239	9,599	7,401	1962	112,076	112,281	----------

[1] Preliminary figures.

Kansas had 39,785 stripper wells producing oil on January 1, 1963, 1,166 less than in 1961.[4] Yield of stripper wells was 70 million barrels, about 64 percent of the Kansas petroleum output, compared with 73.6 million barrels and 66 percent in 1961. Oil reserves attributed to stripper wells totaled 503 million barrels, compared with 561 million barrels in 1961.

[3] Oil and Gas Journal. V. 62, No. 14, Apr. 16, 1964, p. 123.
[4] Oil and Gas Journal. V. 61, No. 45, Nov. 11, 1963, p. 94.

TABLE 16.—Pipeline runs of crude petroleum by fields[1]

(Thousand barrels)

Field[2]	1959	1960	1961	1962	1963
Bemis-Shutts	4,868	4,472	4,116	3,988	3,750
Chase-Silica	3,689	3,219	2,919	3,902	2,814
El Dorado	4,443	4,291	4,239	3,986	3,556
Fairport					1,044
Geneseo-Edwards	1,680	1,565	1,529	1,454	1,284
Gorham	1,421	1,311	1,238	1,196	1,386
Hall-Gurney	3,253	3,229	3,291	3,199	3,205
Hanston-Oppy					1,235
Kismet				1,099	1,097
Kraft-Prusa	2,890	2,526	2,317	2,147	2,085
Lost Springs	1,704	1,914	2,350	1,848	1,233
Marcotte	1,596	1,424	1,258	1,163	1,034
Morel	1,354	1,299	1,239	1,227	1,145
Pleasant Prairie	1,369	1,839	1,719	1,676	1,440
Ray	1,363	1,289	1,306	1,322	1,259
Ritz-Canton	1,321	1,199	1,120	1,396	1,049
Spivey-Grabs-Basil	2,370	2,492	3,726	3,949	3,648
Trapp	3,120	2,752	2,542	2,439	2,874
Other fields[3]	83,062	78,523	77,302	76,035	75,008
Total	119,503	113,344	112,211	112,026	110,146
Change in field stocks[3]	+40	+109	+30	+50	−1,039
Total production[3]	119,543	113,453	112,241	112,076	[4] 109,107

[1] Fields with current annual pipeline runs in excess of 1 million barrels.
[2] Breakdown for individual fields from Kansas Geological Survey.
[3] Bureau of Mines figures.
[4] Preliminary figure.

TABLE 17.—Important oilfields discovered in 1963

(Barrels per day)

Field	County	Initial production
Chaffee	Barton	229
Benfer	Butler	45
Harlan	do	57
Wehrman	do	64
Cooley	Cowley	30
Farlington	Crawford	12
Gregory	Ellsworth	57
Oxhide	do	89
Garvey Ranch	Gove	155
Kohart	Graham	93
Eakin Northwest	Hodgeman	30
Goebel East	do	109
Lippoldt	do	79
Mellecker	do	111
Saw Log Creek Southeast	do	325
Buda	Ness	104
McDonald	do	102
Sunshine	do	158
Wunder	do	94
Lyons West	Rice	91
Pihl	Saline	33
Rychlec	Stafford	98
Muhlheim	Trego	131

Source: State Geological Survey of Kansas, Oil and Gas Developments in Kansas during 1963. Bull. 172 (advance).

State Regulations.—The Kansas Corporation Commission assumed jurisdiction of all gas pipelines in the State and issued an order to all gas pipeline companies to show cause why they should not be required to obtain a certificate of convenience and necessity from the Commission and to file rate tariffs on charges made for intrastate sales to Kansas main-line industrial consumers. The action was a response

TABLE 18.—Leading oilfields[1]

(Thousand barrels)

Field	County	Discovery date	Annual production			Cumulative production		
			1961	1962	1963	Dec. 31, 1961	Dec. 31, 1962	Dec. 31, 1963
El Dorado	Butler	1915	4,239	3,986	3,556	249,713	253,670	257,255
Chase-Silica	Barton, Rice, Stafford	1931	2,919	2,902	2,814	221,451	224,687	227,309
Bemis-Shutts	Ellis, Rooks	1935	4,116	3,988	3,750	180,096	184,084	187,835
Trapp	Barton, Russell	1936	2,542	2,439	2,875	169,755	172,195	183,458

[1] Fields with cumulative production in excess of 100 million barrels.

Source: State Geological Survey of Kansas, Oil and Gas Developments in Kansas during 1963. Bull. 172 (advance).

to the efforts of the Federal Power Commission to obtain jurisdiction over unregulated industrial sales through legislative action.

Pipelines.—Pipeline construction continued during 1963. Cities Service Oil Co. constructed a 180-million pipeline to transmit deethanized natural gas feedstock from Ulysses to Hutchinson for processing in its new fractionation plant. Cities Service Gas Co. constructed 7 miles of 26-inch pipeline near Lawrence, replacing the 18- and 20-inch gas transmission line. The company received authorization to expand its gas pipeline system in the Kansas City area. Included were about 25 miles of pipeline loop, metering, and regulating facilities, and transmission line taps. The company has also planned construction of 10 miles of 30-inch pipeline between Welda and Ottawa, and 7 miles of 20-inch pipeline between Ottawa and Peculiar, Mo.

Northern Gas Products Co., subsidiary of Northern Natural Gas Co., began construction of its 8-inch pipeline from Bushton to Des Moines, Iowa, a distance of 350 miles.

Drilling and Exploration.—Wells reported drilled in Kansas in 1963 totaled 3,656, compared with 3,803 in 1962.[5] In addition to the reported well drilling, an estimated 786 wells were drilled mostly in eastern Kansas, according to permits filed with the Kansas Corporation Commission and other reliable data sources. This compared with 560 wells in 1962.

Drilling decreased in the western ranges; in eastern Kansas it decreased in the deeper areas and increased in the shallow area. Drilling in the central Kansas Uplift continued to be the most active during the year.

Petrochemicals.—Cooperative Farm Chemicals Association completed expansion of its fertilizer complex at Lawrence in Douglas County; ammonia capacity was increased 150 tons per day to 570 tons per day, and nitric acid capacity was increased 350 tons per day to 830 tons per day.

[5] Hilpman, P. L., and Others. Oil and Gas Developments in Kansas during 1963. Kans. Geol. Survey Bull. 172 (advance).

TABLE 19.—Oil and gas well drilling in 1963

County	Wells drilled					Unclassified [2]	Total
	Oil	Gas	Oil and gas	Service [1]	Dry		
Allen	35			30		85	150
Anderson	15			18		19	52
Atchison					1		1
Barber	8	19	5	2	36		70
Barton	86	1	1	2	107		197
Bourbon	6					9	15
Brown					1		1
Butler	76			24	58	32	190
Chase	1				4		5
Chautauqua	20			10	9	26	65
Cheyenne					4		4
Clark		4	2		7		13
Clay					1		1
Coffey	3					9	12
Comanche	1	3			12		16
Cowley	63	2	1	6	64		136
Crawford	12			7		44	63
Decatur	3				14		17
Dickinson				1	3		4
Douglas	8			6	1	18	33
Edwards	5	3		1	16		25
Elk	7			5	5	5	22
Ellis	88			4	107		199
Ellsworth	12			5	21		38
Finney	10	2		2	7		21
Ford		1			13		14
Franklin	14			8		30	52
Gove	2				26		28
Graham	25			5	42		72
Grant	1	8			4		13
Gray					3		3
Greeley		1			9		10
Greenwood	78			22	41		141
Hamilton		39			6		45
Harper	9	5	2	1	12		29
Harvey	15	2		13	17	10	57
Haskell	11	10	5	1	10		37
Hodgeman	86			6	79		171
Jackson	2				1		3
Johnson	3					12	15
Kearny		1			11		12
Kingman	19	7	1		45		72
Kiowa		1	1	2	12		16
Labette	18			23		9	50
Lane	6				18		24
Leavenworth	4					28	32
Lincoln						4	4
Linn	2			2		11	15
Logan					1		1
Lyon	3				3		6
McPherson	19			1	25		45
Marion	32		1		19		52
Marshall					2		2
Meade	2	5	1		13		21
Miami	12			14		44	70
Montgomery	12	1		16		26	55
Morris		2			2		4
Morton	15	8	2		16		41
Neosho	26			42		172	240
Ness	48			6	84		138
Norton	2			1	15		18
Osborn					1		1
Pawnee	14		1	1	20		36
Phillips	6			2			8
Pottawatomie					2		2
Pratt	4	3	2		31		40
Rawlins	4				14		18
Reno	18	2	4	3	29	24	80
Rice	174	3		2	77		256
Riley	2				2		4
Rooks	46			7	51		104
Rush	2	10		1	21		34
Russell	102			8	64	11	185
Saline	30			3	17		50
Scott	2				10		12
Sedgwick	23			1	40		64

See footnotes at end of table.

TABLE 19.—Oil and gas well drilling in 1963—Continued

County	Wells drilled					Unclassified [2]	Total
	Oil	Gas	Oil and gas	Service [1]	Dry		
Seward	2	16	1	2	11		32
Sheridan	2				4		6
Sherman					1		1
Stafford	53	4	1	2	87		147
Stanton					2		2
Stevens		4	1		2		7
Sumner	15	2		9	39		65
Thomas					3		3
Trego	25			1	32	5	63
Wabaunsee	1				6		7
Wallace					3		3
Wilson	36			28		96	160
Woodson	17			20		57	94
Total:							
1963	1,503	169	32	376	1,576	786	4,442
1962	1,532	205	61	364	1,641	560	4,363

[1] Service wells are waterflood wells, water-input wells, and salt-water disposal wells.
[2] Estimate.

Source: State Geological Survey of Kansas. Oil and Gas Developments in Kansas during 1963. Bull. 172 (advance).

TABLE 20.—Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

Product	Proved reserves, Dec. 31, 1962	Changes in proved reserves, due to extensions and new discoveries in 1963	Proved reserves, Dec. 31, 1963 (production was deducted)	Changes from 1963, percent
Crude oil—thousand barrels	862,410	87,755	841,349	−2
Natural gas liquids [1]—do	179,096	−2,136	169,241	−6
Natural gas—million cubic feet	18,567,174	210,249	17,994,235	−3

[1] Includes condensate, natural gasoline, and LP gases.

Source: American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. Proved Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas. V. 18, Dec. 31, 1963, pp. 11, 12, 23.

Frontier Chemical Co. completed its 15,000-ton-per-year ammonia plant at Wichita in Sedgwick County. An additional 30 employees were required to operate the plant. Racon, Inc., announced plans for a $2 million chemical plant to be constructed near the Frontier Chemical Co. plant. The plant would produce 12.5 million pounds of fluorocarbons per year, using chloroform and carbon tetrachloride supplied by pipeline from Frontier. The fluorocarbons are used as refrigerants in the aerosol propellant field.

Skelly Oil Co. began operating its new aromatics complex in November. Using naphtha fractions as raw material, the plant can produce phenol (50,000 pounds per year), cumene, benzene, toluene, xylene, acetone, and other high-solvency naphtha compounds.

NONMETALS

Total value of nonmetals produced in 1963 was $70 million, $2 million greater than the value of production in 1962. All seven nonmetals recorded gains in value of production over that of 1962.

Cement.—Plants in Allen, Montgomery, Neosho, Wilson, and Wyandotte Counties produced 8.2 million barrels of portland cement, utilizing an average 67 percent of total capacity. About 65 percent of the cement was produced by the wet process and 35 percent by the dry process. Shipments totaled 8.2 million barrels valued at $25.4 million, an increase of nearly 2 percent in volume and 1 percent in value over that of 1962. Based on reports of five of the six portland cement plants, 68 percent of shipments were by rail and 32 percent by truck. Six plants reported 85 percent of shipments in bulk and 15 percent in paper bags.

Distribution of shipments by type of customer included ready-mixed concrete companies, 57 percent; highway contractors, 14 percent; building material dealers, 12 percent; other contractors, 8 percent; concrete product manufacturers, 6 percent; miscellaneous customers, 2 percent; and Federal, State, and local government agencies, 1 percent. About 54 percent of total shipments were within Kansas, 29 percent to Missouri, 10 percent to Oklahoma, 3 percent to Arkansas, 3 percent to Nebraska, and 1 percent to Texas.

TABLE 21.—Portland cement production and shipments

(Thousand 376-pound barrels and thousand dollars)

Year	Production	Shipments		Year	Production	Shipments	
		Quantity	Value			Quantity	Value
1954–58 (average)	9,174	9,110	$26,040	1961	8,329	8,028	$25,605
1959	10,177	10,056	30,889	1962	8,235	8,058	25,134
1960	7,996	7,877	25,194	1963	8,248	8,201	25,372

TABLE 22.—Shipments of portland cement to Kansas consumers

Year	Kansas (thousand 376-pound barrels)	Change, percent		Year	Kansas (thousand 376-pound barrels)	Change, percent	
		In Kansas	In United States			In Kansas	In United States
1954–58 (average)	6,437	----------	----------	1961	5,770	+14	+3
1959	6,889	+8	+9	1962	5,331	−8	+3
1960	5,070	−26	−7	1963	5,024	−6	+5

Masonry cement was produced at all portland cement plants and at a natural cement plant in Bourbon County. Production of masonry cement increased 8 percent over that of 1962 but shipments decreased 1 percent. About 47 percent of shipments were within Kansas, 28 percent to Missouri, 16 percent to Oklahoma, 7 percent to Arkansas, and 2 percent to various States.

Clays.—Clay and shale production decreased slightly; total value increased about 1 percent. The use pattern of Kansas clay and shale was 42 percent for cement, 29 percent for building brick, and 29 percent for lightweight aggregate, sewer pipe, heavy clay products, stoneware, and pottery.

Brick production totaled 113.5 million units[6] compared with 114 million units in 1962. Lightweight aggregate was produced from shale in Franklin and McPherson Counties by Buildex, Inc. Brick manufacturers included Humboldt Brick & Tile Co., Kansas Brick & Tile Co., Acme Brick Co., Cloud Ceramics, and Excelsior Brick Co. W. S. Dickey Clay Manufacturing Co. produced sewer pipe; the company announced plans to build a new research center and machine shop at its Pittsburg plant.

TABLE 23.—Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954–58 (average)	877	$1,111	1961	954	$1,225
1959	1,021	1,271	1962	895	1,091
1960	894	1,224	1963	893	1,104

Gypsum.—Production of crude and calcined gypsum increased in tonnage and value. Gypsum was mined underground by National Gypsum Co. near Medicine Lodge, Barber County, and by Bestwall Gypsum Co. at Blue Rapids, Marshall County.

Kansas crude gypsum was used as a retarder in portland cement, as a soil conditioner, as a filler in paper and paint, as mild abrasives, and as a base in insecticides. Principal uses of calcined gypsum were in manufacturing wallboard and wall plaster.

Perlite.—Crude perlite, mined in Western States, was processed by Lite Weight Products, Inc., at Kansas City. The expanded perlite was used for filler material, building plaster aggregate, concrete aggregate, soil conditioning, and loose-fill insulation.

Pumice.—Pumicite (volcanic ash) was mined by Wyandotte Chemical Corp. in Norton County and by Ernest Hanzlicek in Lincoln County. Volcanic ash was used in cleansing and scouring compounds, hand soaps, and dusting powders. Output was greater than that in 1962.

Salt.—Evaporated and rock salt were produced by six companies in Barton, Ellsworth, Reno, and Rice Counties; tonnage sold or used decreased 2 percent, and value increased 3 percent. One company produced rock salt, three produced evaporated salt, and two produced both rock and evaporated salt.

Meatpackers, livestock raisers, leather tanners, feed dealers, and canners were large consumers of salt. Large amounts also were used for road stabilization and snow and ice removal.

Brine was produced in Sedgwick County by Frontier Chemical Co., a division of Vulcan Materials, for manufacturing chlorine, caustic soda, and inorganic compounds.

Atomic Energy Commission continued investigating the feasibility of nuclear waste disposal in natural salt formations in the inactive Carey Salt Co. mine at Lyons in Rice County.

[6] University of Kansas, Center for Research in Business, Kansas Business Review. V. 17, No. 3, March 1964, p. 18.

TABLE 24.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Evaporated salt		Rock salt		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	415	$6,679	561	$2,737	976	$9,416
1959	389	9,035	[1] 734	[1] 4,635	1,123	13,670
1960	402	9,358	[1] 811	[1] 4,751	1,213	14,109
1961	411	9,180	502	2,229	[2] 913	[2] 11,409
1962	432	9,446	512	2,208	[2] 944	[2] 11,654
1963	435	9,669	489	2,324	[2] 924	[2] 11,993

[1] Brine included with rock salt (previously include with evaporated salt) to avoid disclosing individual company confidential data.
[2] Excludes brine.

Underground Vault & Storage Co., Inc., maintained industrial storage facilities in a section of the Carey Salt Co. mine at Hutchinson in Reno County.

Sand and Gravel.—Sand and gravel was produced in 81 counties at 157 commercial operations and 74 Government-and-contractor operations. Over 89 percent of total production was used for building and highway construction. Commercial operations furnished 81 percent of total tonnage and 88 percent of total value; the remainder was Government-and-contractor output. More than 87 percent of total production was processed. Shipments of commercial production was 94 percent by truck and 6 percent by rail. Leading counties, in terms of production value, were Wyandotte, Sedgwick, Saline, Shawnee, and Russell.

Stone.—Limestone, sandstone, and miscellaneous stone were quarried in 52 counties. Limestone production from 51 counties supplied 95 percent of total tonnage and value. Crushed limestone was produced in 51 counties at 121 commercial and 16 Government-and-contractor operations. Dimension limestone was quarried and prepared at 12 operations in 7 counties.

Crushed sandstone was produced in Atchison, Graham, Lincoln, Neosho, and Norton Counties. Dimension sandstone was quarried in Bourbon County.

TABLE 25.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total sand and gravel	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	8,792	$6,274	1,861	$740	10,653	$7,014
1959	9,257	6,661	2,077	1,276	11,334	7,937
1960	8,178	6,148	1,532	660	9,710	6,808
1961	8,975	6,722	2,391	1,059	11,366	7,781
1962	9,274	6,953	2,278	1,086	11,552	8,039
1963	9,763	7,603	2,299	1,073	12,062	8,676

TABLE 26.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	3,221	$2,364	3,313	$2,456
Paving	3,264	2,495	2,814	2,265
Fill	893	440	876	413
Other [1]	94	117	186	200
Total sand	7,472	5,416	7,189	5,334
Gravel:				
Building	270	223	366	402
Paving	1,356	1,150	1,992	1,683
Fill	69	76	59	29
Other [2]	107	88	157	155
Total gravel	1,802	1,537	2,574	2,269
Total sand and gravel	9,274	6,953	9,763	7,603
Government-and-contractor operations:				
Sand:				
Paving	1,167	509	1,234	605
Other [3]	24	14	14	5
Total sand	1,191	523	1,248	610
Gravel: Paving	1,087	563	1,051	463
Total sand and gravel	2,278	1,086	2,299	1,073
Grand total	11,552	8,039	12,062	8,676

[1] Includes railroad ballast, other construction, and industrial sand (unground).
[2] Includes other construction and miscellaneous gravel.
[3] Includes other (1963) and fill.

Crushed miscellaneous stone was produced in Cherokee and Rawlins Counties.

Principal uses for crushed stone were for cement, concrete aggregate, roadstone, riprap, railroad ballast, and agricultural stone; dimension stone was used as building stone, curbing, and flagging. Commercial producers supplied 91 percent of total stone output.

Vermiculite.—Dodson Manufacturing Co. produced exfoliated vermiculite at its plant at Wichita, Sedgwick County. Crude vermiculite was purchased from Zonolite Co., Libby, Mont. Output was less than that in 1962.

Water.—Water resources development in Kansas continued as Congress passed the Federal Public Works Appropriation bill. The bill authorized spending $58.7 million for construction and detailed planning on 16 U.S. Army Corps of Engineers projects and 9 Bureau of Reclamation projects. The 25 projects included 14 reservoirs which will provide 6.3 million acre-feet of storage, 5 local protection works, and 6 irrigation units. Soil Conservation Service received $4 million from appropriations of the Department of Agriculture for construction and planning of watershed projects in the State.

During the year, the Tuttle Creek Dam and Reservoir near Manhattan in Riley County was dedicated. The dam, which will hold a maximum of 2.3 million acre-feet of water, was built to contain the Blue River, a source of floods in the Kaw River Valley. Construction began in 1952; total cost was $82 million.

TABLE 27.—Sand and gravel production in 1963, by counties

County	Short tons	Value	County	Short tons	Value
Allen	3,000	$3,000	Lyon	165,284	$148,548
Anderson	5,000	2,000	McPherson	53,427	20,800
Barber	32,465	18,475	Mitchell	20,050	25,540
Barton	278,920	150,105	Morris	55,394	24,241
Brown	15,988	6,395	Nemaha	55,799	55,635
Butler	7,802	3,979	Ness	81,669	32,668
Chase	58,003	21,225	Norton	7,250	2,900
Cherokee	34,893	13,957	Osborne	27,270	10,660
Cheyenne	124,260	76,858	Ottawa	75,575	30,230
Clark	21,932	9,504	Pawnee	111,353	74,304
Clay	86,056	75,213	Phillips	12,878	5,151
Coffey	25,190	10,076	Pottawatomie	49,624	42,554
Comanche	26,838	10,735	Pratt	137,722	58,715
Cowley	387,741	275,117	Reno	468,769	273,738
Decatur	66,803	40,117	Republic	267,235	202,457
Doniphan	18,036	7,214	Rice	210,566	108,286
Ellis	92,627	58,851	Rooks	2,700	2,025
Ellsworth	119,743	68,467	Rush	19,904	12,580
Ford	209,691	148,544	Sedgwick	1,589,498	924,408
Franklin	11,895	4,758	Seward	54,196	111,678
Gove	46,541	25,560	Shawnee	557,503	365,365
Grant	54,800	24,000	Sherman	59,332	50,264
Greeley	9,590	3,836	Stafford	31,150	22,662
Harper	113,459	51,143	Sumner	136,780	75,740
Harvey	110,000	61,500	Thomas	89,363	75,970
Haskell	20,250	8,100	Trego	108,463	70,330
Hodgeman	79,594	31,838	Wichita	54,468	33,737
Johnson	163,257	125,872	Wilson	43,350	17,340
Kearny	62,931	36,802	Wyandotte	1,854,546	1,456,157
Kiowa	112,455	52,488	Other counties [1]	3,172,423	2,842,383
Leavenworth	26,101	29,088	Total	12,062,418	8,675,683
Linn	22,749	9,100			
Logan	40,267	34,700			

[1] Includes Cloud, Douglas, Edwards, Finney, Geary, Graham, Gray, Hamilton, Jackson, Kingman, Lincoln, Marshall, Neosho, Rawlins, Riley, Russell, Saline, Wallace, and Washington Counties, combined to avoid disclosing individual company data. Undistributed amounts from various counties are also included.

TABLE 28.—Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Limestone [1]		Miscellaneous stone		Total stone	
	Quantity	Value	Quantity	Value	Quantity	Value
1959	13,367	$16,883	632	$225	[2] 13,999	[2] $17,108
1960	11,446	14,899	[3] 368	[3] 132	[4] 11,814	[4] 15,031
1961	11,948	16,242	[3] 380	[3] 169	[4] 12,328	[4] 16,411
1962	13,098	17,106	[3] 429	[3] 168	[4] 13,527	[4] 17,274
1963	12,904	17,600	[5] 654	[5] 883	13,558	18,483

[1] Includes diatomaceous marl, limestone for cement, and limestone for lime (1961, 1962, and 1963).
[2] Excludes sandstone.
[3] Includes dimension sandstone.
[4] Excludes crushed sandstone.
[5] Includes dimension and crushed sandstone.

TABLE 29.—Stone sold or used by producers, by kinds and uses

(Short tons)

Uses	1962		1963	
	Quantity	Value	Quantity	Value
Limestone: [1]				
Riprap	843,247	$882,473	997,648	$1,263,220
Concrete aggregate and roadstone	9,210,465	12,250,667	8,874,031	11,718,011
Agriculture	404,422	645,663	439,525	751,862
Cement	2,163,164	2,275,033	2,127,194	2,242,798
Dimension	9,642	130,805	21,744	689,657
Other [2]	467,183	921,941	443,250	934,380
Total limestone	13,098,123	17,106,582	12,903,392	17,599,928
Sandstone:				
Crushed	(3)	(3)	410,839	741,247
Dimension	654	10,157	447	8,887
Miscellaneous stone	428,401	157,686	243,066	133,164
Total stone	[4] 13,527,178	[4] 17,274,425	13,557,744	18,483,226

[1] Includes diatomaceous marl.
[2] Includes railroad ballast, cement rock, coal dust, lime (1962), mineral food (1962), whiting, other filler (1962), and flux (1963).
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Excludes crushed sandstone.

METALS

The Kansas lead- and zinc-producing area (Cherokee County) is part of the Tri-State District, which also includes northeastern Oklahoma and southwestern Missouri. Further details on Tri-State activity are given in the Oklahoma chapter.

The Lead-Zinc Mining Stabilization Program (Public Law 87–347) was in effect during 1963. Status of the program at yearend showed six applications certified in Kansas, four active and two inactive. The program was modified during 1963 and producers were required to resubmit their applications. At yearend, one reapplication and been made in Kansas. Payments by General Services Administration in 1963 on Kansas sales totaled $32,474 for lead and $71,190 for zinc. These amounts are excluded from the value of lead and zinc mine production reported in this chapter.

Smelters.—The Eagle-Picher Co. produced lead pigments and sulfuric acid at its lead smelter and acid plant near Galena. Feedstock for the smelter was supplied by captive mines and independent producers in the Tri-State District and Southern Illinois. Ozark Smelting & Mining Co. operated its pigment plant at Coffeyville. Cherryvale Zinc Co. was conducting experiments on the production of metal oxide for industrial use.

Lead.—Mine production of recoverable lead increased 6 percent. The Grace B mine of The Eagle-Picher Co. was the largest producer, followed by the Lucky Jew and Big John mines operated by Mid-Continent Lead & Zinc Co. Other operators included Tucker-Henderson Mining Co., Merit Mining Co., B & I Mining Co., and C. A. Enders Mining Co.

Zinc.—Zinc output dropped 11 percent. Leading producers were The Eagle-Picher Co., Mid-Continent Lead & Zinc., and Tucker-Henderson Mining Co. Kansas zinc and lead ores were concentrated at the Barbara J mill of American Zinc, Lead and Smelting Co. and Central mill of The Eagle-Picher Co., both in Oklahoma, and the Robinson mill of Tucker-Henderson Mining Co., near Treece, Kans.

REVIEW BY COUNTIES

Mineral production was reported in all of the 105 counties, 2 more than reported in 1962. Sixty-one counties reported mineral production valued at $1 million or more each, three more than in 1962. The five principal mineral producing counties were Ellis, Grant, Barton, Russell, and Stevens; these counties accounted for 24 percent of the total value of mineral production in the State. Selected counties with significant mineral developments are discussed in the following review.

TABLE 30.—Mine production of lead and zinc, in terms of concentrate and recoverable metals[1]

Year	Mines producing	Lead concentrate (galena)		Zinc concentrate (sphalerite)		Recoverable metal content[2]			
						Lead		Zinc	
		Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1954–58 (average)	-------	6,083	$1,099	36,138	$2,824	4,544	$1,332	19,133	$4,671
1959	11	702	93	1,971	149	481	111	1,017	234
1960	4	1,411	129	4,162	314	781	183	2,117	546
1961	9	1,910	222	4,730	311	1,449	298	2,446	563
1962	10	1,290	138	7,237	493	970	178	3,943	907
1963	8	1,402	172	6,433	514	1,027	222	3,508	807

[1] Based on Kansas ore and old tailing treated at mills during calendar year indicated.
[2] In calculating metal content of the ores from assays, allowance made for smelting losses of both lead and zinc. In comparing values of concentrate (ore) and metal, value given for concentrate is that actually received by producer, whereas value of lead and zinc is calculated from average price for all grades.

TABLE 31.—Value of mineral production in Kansas, by counties

County	1962[1]	1963	Minerals produced in 1963 in order of value
Allen	$12,556,849	$11,789,258	Cement, petroleum, stone, clays, natural gas, sand and gravel.
Anderson	1,273,244	1,175,055	Petroleum, stone, natural gas, sand and gravel.
Atchison	(2)	307,213	Stone.
Barber	8,791,921	8,830,117	Natural gas, petroluem, gypsum, natural gas, liquids, sand and gravel.
Barton	27,824,925	25,540,779	Petroleum, natrual gas, sand and gravel, clays, salt.
Bourbon	790,241	792,530	Stone, petroleum, cement, coal.
Brown	-------	6,395	Sand and gravel.
Butler	21,198,603	19,408,806	Petroleum, stone, natural gas, sand and gravel.
Chase	316,100	360,923	Petroleum, stone, sand and gravel, natural gas.
Chautauqua	2,369,299	2,384,258	Petroleum, natural gas.
Cherokee	4,160,925	4,668,310	Coal, zinc, lead, stone, clays, sand and gravel.
Cheyenne	52,830	81,478	Sand and gravel, petroleum.
Clark	1,696,691	2,122,160	Natural gas, petroluem, sand and gravel.
Clay	232,486	92,366	Sand and gravel, petroleum.
Cloud	332,213	582,220	Stone, clays, sand and gravel.
Coffey	678,653	538,660	Stone, petroleum, sand and gravel, coal, natural gas.
Comanche	832,961	1,161,448	Natural gas, petroleum, sand and gravel.
Cowley	13,362,921	12,291,775	Petroleum, stone, natural gas, sand and gravel.
Crawford	(2)	(2)	Coal, petroleum, clays, natural gas.
Decatur	1,476,952	1,533,261	Petroleum, sand and gravel.
Dickinson	697,927	785,639	Stone, petroleum, natural gas.
Doniphan	487,297	457,386	Stone, sand and gravel.
Douglas	306,413	254,847	Stone, sand and gravel, petroleum, natural gas.
Edwards	2,038,446	1,677,006	Petroleum, natural gas, sand and gravel.
Elk	1,241,032	1,148,584	Stone, petroleum, natural gas.
Ellis	28,935,818	27,445,146	Petroleum, sand and gravel, stone.
Ellsworth	5,479,403	16,454,407	Natural gas liquids, petroleum, salt, sand and gravel, clays, natural gas.
Finney	12,442,339	12,970,218	Natural gas, petroleum, natural gas liquids, sand and gravel.
Ford	499,426	463,373	Natural gas liquids, sand and gravel, petroleum, natural gas.
Franklin	1,151,156	874,160	Petroleum, clays, stone, natural gas, sand and and gravel.
Geary	728,387	692,749	Stone, sand and gravel, petroleum.
Gove	294,511	266,143	Petroleum, sand and gravel.
Graham	15,866,274	15,419,962	Petroleum, stone, sand and gravel.
Grant	19,142,306	24,713,334	Natural gas, natural gas liquids, petroleum, sand and gravel.
Gray	55,746	(2)	Sand and gravel.
Greeley	7,290	3,836	Do.
Greenwood	10,701,905	9,586,750	Petroleum, stone, natural gas.
Hamilton	188,967	330,740	Natural gas, petroleum, sand and gravel.
Harper	3,583,510	4,087,439	Petroleum, natural gas, sand and gravel.
Harvey	1,843,400	2,078,646	Petroleum, natural gas, sand and gravel, natura gas liquids.

See footnotes at end of table.

TABLE 31.—Value of mineral production in Kansas, by counties—Continued

County	1962[1]	1963	Minerals produced in 1963 in order of value
Haskell	$10,820,736	$9,751,081	Natural gas, petroleum, sand and gravel.
Hodgeman	2,683,698	5,715,714	Petroleum, sand and gravel.
Jackson	(2)	89,809	Sand and gravel, stone, petroleum.
Jefferson	(2)	(2)	Stone.
Jewell	(2)	(2)	Do.
Johnson	640,551	1,103,777	Stone, sand and gravel, petroleum, natural gas.
Kearny	9,037,394	10,291,667	Natural gas, natural gas liquids, petroleum, sand and gravel.
Kingman	17,104,457	16,459,535	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kiowa	3,057,425	3,037,010	Natural gas, petroleum, sand and gravel.
Labette	407,796	343,073	Petroleum, stone, natural gas.
Lane	144,765	223,357	Petroleum.
Leavenworth	430,029	148,845	Stone, natural gas, sand and gravel, petroleum.
Lincoln	(2)	941,494	Stone, sand and gravel, pumice.
Linn	347,601	296,602	Petroleum, stone, natural gas, sand and gravel.
Logan	3,494	34,700	Sand and gravel.
Lyon	493,815	537,474	Petroleum, sand and gravel, stone.
Marion	9,801,908	7,530,652	Petroleum, natural gas liquids, natural gas, stone.
Marshall	852,404	1,049,180	Gypsum, sand and gravel, stone.
McPherson	9,464,906	7,812,510	Petroleum, clays, natural gas, sand and gravel.
Meade	4,194,618	4,058,699	Petroleum, natural gas.
Miami	1,238,835	760,154	Petroleum, stone, natural gas.
Mitchell	(2)	25,540	Sand and gravel.
Montgomery	5,333,522	5,320,696	Cement, petroleum, stone, natural gas, clays.
Morris	1,551,253	1,550,032	Petroleum, stone, natural gas, sand and gravel.
Morton	15,443,310	16,601,741	Natural gas, petroleum, natural gas liquids.
Nemaha	64,151	80,916	Sand and gravel, petroleum, stone.
Neosho	7,443,543	8,009,066	Cement, petroleum, stone, sand and gravel, clays, natural gas.
Ness	2,193,296	3,044,180	Petroleum, sand and gravel.
Norton	2,324,499	2,007,805	Petroleum, stone, pumice, sand and gravel.
Osage	18,884	7,936	Coal, stone.
Osborne	183,214	161,572	Petroleum, stone, sand and gravel.
Ottawa	----------	30,230	Sand and gravel.
Pawnee	3,490,955	3,307,501	Petroleum, natural gas, sand and gravel.
Phillips	6,348,186	6,213,228	Petroleum, stone, sand and gravel.
Pottawatomie	136,144	217,922	Stone, sand and gravel.
Pratt	4,932,591	4,464,091	Petroleum, natural gas, sand and gravel.
Rawlins	2,220,608	2,281,155	Petroleum, stone, sand and gravel.
Reno	12,048,305	13,976,745	Salt, petroleum, natural gas liquids, natural gas, sand and gravel.
Republic	(2)	206,857	Sand and gravel, stone.
Rice	15,389,325	18,076,224	Petroleum, salt, stone, sand and gravel, natural gas.
Riley	1,052,319	743,922	Petroleum, stone, sand and gravel.
Rooks	15,053,811	16,088,113	Petroleum, sand and gravel.
Rush	2,765,159	2,882,795	Helium, petroleum, natural gas, sand and gravel.
Russell	23,341,989	24,831,832	Petroleum, sand and gravel, natural gas.
Saline	2,741,196	2,590,084	Petroleum, sand and gravel.
Scott	191,977	153,325	Petroleum, natural gas.
Sedgwick	11,677,350	11,753,521	Petroleum, salt, natural gas liquids, sand and gravel, natural gas.
Seward	10,217,453	9,329,137	Petroleum, natural gas, natural gas liquids, sand and gravel.
Shawnee	(2)	615,365	Sand and gravel, stone.
Sheridan	780,501	1,064,579	Petroleum.
Sherman	198,893	177,470	Petroleum, sand and gravel.
Smith	22,600	320,732	Stone.
Stafford	17,564,795	15,804,410	Petroleum, natural gas, sand and gravel.
Stanton	2,618,079	2,806,506	Natural gas, petroleum.
Stevens	19,149,116	20,504,181	Do.
Sumner	8,916,927	8,788,328	Petroleum, sand and gravel, natural gas.
Thomas	35,023	75,970	Sand and gravel.
Trego	4,622,172	4,645,882	Petroleum, sand and gravel, stone.
Wabaunsee	852,021	(2)	Petroleum, stone.
Wallace	(2)	(2)	Stone, sand and gravel.
Washington	78,479	(2)	Sand and gravel.
Wichita	18,651	36,893	Sand and gravel, petroleum.
Wilson	5,779,622	5,715,236	Cement, petroleum, stone, clays, natural gas, sand and gravel.
Woodson	2,469,383	2,221,027	Petroleum, stone, natural gas.
Wyandotte	8,508,337	8,183,798	Cement, stone, sand and gravel, clays.
Undistributed	8,934,562	9,822,747	
Total	501,076,000	518,302,000	

[1] Revised figures.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Allen.—Allen County ranked first in cement production, second in value of clay output, and third in value of stone production. Portland and masonry cements were produced by Lehigh Portland Cement Co. at Iola and The Monarch Cement Co. at Humboldt. Limestone and clay for cement were obtained near the plant sites. Miscellaneous clay for heavy clay products was mined by Humboldt Brick & Tile Co. Limestone was quarried and crushed for concrete aggregate and roadstone by Allen County Highway Department and the Monarch Cement Co. Yield of crude petroleum, mainly by secondary recovery operations, totaled 858,000 barrels, a decrease of 9 percent from that of 1962. Natural gas production increased 264 percent to 656 million cubic feet.

Anderson.—Petroleum output was about equal to that of 1962; secondary recovery projects accounted for most of the production. Over 65 million cubic feet of natural gas was recovered. Limestone was quarried and crushed for concrete aggregate, roadstone, and railroad ballast by Murray Limestone Products and Hunt Rock Co. Anderson County Highway Department produced gravel for paving and road maintenance.

Atchison.—Limestone was quarried and crushed for concrete aggregate, roadstone, riprap, and agstone by George W. Kerford Quarry Co., Ralph H. Bromley & Sons Quarry, and Atchison County Highway Department. Mid-Continent Stone & Construction Co. produced broken sandstone for use as riprap.

Barber.—The county ranked first in gypsum production and seventh in natural gas production. National Gypsum Co. mined and processed gypsum at Medicine Lodge. Natural gas production totaled 41 billion cubic feet, an increase of 6 percent over that of 1962. Output of crude petroleum decreased 7 percent to 995,000 barrels. Exploratory drilling resulted in two important gasfields, DeGeer Southwest and Groendycke. Skelly Oil Co. recovered natural gas liquids at its Medicine Lodge plant. Sand and gravel for building and paving was produced by Whitfield & Son, Burl Gaunt, and Barber County Highway Department.

Barton.—Barton County ranked second in petroleum production and second in value of mineral production. Petroleum production totaled 8.6 million barrels, a decrease of 8 percent. The Chaffee oilfield, with initial production of 229 barrels per day, was the most important discovery in 1963. Natural gas production increased 25 percent over that of 1962. Pawnee Salt Co. produced evaporated salt from brine wells at Pawnee Rock. Kansas Brick & Tile Co. used fire clay for manufacturing building brick. Building and paving sand and gravel was produced by Arkansas Sand Co., James Dirks Sand & Gravel, DuBois & Stone Sand Co., Clifford Klepper Sand Co., and Barton County Highway Department.

Bourbon.—Petroleum production totaled 72,000 barrels, 27 percent less than that in 1962. Coal was strip mined by Palmer Coal Co. and Garrett Coal Co. Fort Scott Hydraulic Cement Co., Inc., manufactured natural and masonry cement near Fort Scott. Bandera Stone Quarry mined and prepared dimension sandstone near Redfield. Limestone was quarried and crushed for concrete aggregate, road-

stone, agstone, and coal mine dusting by Cullor Limestone Co., Inc., and Fort Scott Hydraulic Cement Co., Inc.

Butler.—The county ranked fourth in petroleum production and sixth in total mineral production value. Petroleum output totaled 6.5 million barrels, a decrease of 9 percent from that of 1962. Secondary recovery operations supplied over half of the crude output. Exploratory drilling resulted in discovery of three important oilfields—Benfer, Harlan, and Wehrman. Mobil Oil Co. operated its refinery at Augusta. Mobil Chemical Co. produced carbon black oils and sodium cresylate solutions, using petroleum fractions as feedstock. Skelly Oil Co. operated its refinery at El Dorado and completed construction of its aromatics complex. Using naphtha fractions as feedstock, the plant produced phenol and other naphtha compounds. Vickers Refining Co., Division of Vickers Petroleum Co., Inc., operated its refinery at Potwin. Vickers Petroleum Co., Inc., produced benzene, toluene, xylenes, and other chemicals at its Potwin petrochemical plant using catalytic reformate as feedstock. American Petrofina Co. of Texas operated its refinery at El Dorado. Over 121 million cubic feet of natural gas was recovered in the county.

Limestone was quarried and crushed for concrete aggregate, roadstone, agstone, and riprap by George M. Myers, Inc., Carr Rock Products Co., Murray Limestone Products, and Starnes Rock Products Co. Gravel for road maintenance was obtained by Butler County Highway Department.

Chase.—Petroleum production totaled 72,500 barrels, a decrease of 16 percent from the 1962 output. Secondary recovery operations accounted for most of the production. Natural gas recovery totaled 77 million cubic feet, an increase of 127 percent over that of 1962. Limestone was mined and crushed for concrete aggregate, roadstone, riprap, and agstone by Riddle Quarries, Inc., and Anderson-Oxandale. Dimension limestone was prepared by J.T. Lardner Cut Stone Co., Bayer Stone Co., and H. J. Born Stone Co. Gravel for paving and road maintenance was produced by Chase County Highway Department and Lyon County Highway Department.

Chautauqua.—Yield of crude petroleum increased 3 percent over that of 1962; secondary recovery operations supplied a large part of the output. Natural gas recovery totaled 280 million cubic feet, a 101-percent increase.

Cherokee.—Cherokee County ranked first in coal production. Coal was strip mined by Pittsburg & Midway Coal Co., Wilkinson Coal Co., and Black Diamond Coal Co. Pittsburg & Midway Coal Co. completed construction of a 90-cubic-yard shovel at its strip mine near Hallowell. The entire production of lead and zinc in Kansas was mined in Cherokee County. Miscellaneous stone (chats) was produced by The Eagle-Picher Co. and Southwest Rock & Chat Co. for railroad ballast, concrete aggregate, and roadstone. Acme Brick Co. (formerly United Brick & Tile Co.) mined miscellaneous clay for manufacturing building brick near Weir.

Cheyenne.—Sand and gravel for building, paving, and fill was produced by Whitney Sand Co., New Era Sand & Gravel Co., and Cheyenne County Highway Department. Output of crude petroleum was 1,690 barrels, 5,540 barrels less than that in 1962.

Clark.—Natural gas recovery totaled nearly 12.5 billion cubic feet, an increase of 22 percent. Over 189,000 barrels of crude petroleum was recovered, an increase of 18 percent. Clark County Highway Department obtained gravel for paving and road maintenance.

Clay.—Sand and gravel for building, paving, and fill purposes was produced by Clay Center Concrete & Sand Co., Inc., John H. Alsop Sand Co., and Fyfe Sand & Gravel Co. Slightly over 6,000 barrels of crude petroleum was recovered, 23 percent less than that in 1962.

Cloud.—Cloud County ranked first in value of clay production. Cloud Ceramics mined fire clay for manufacturing building brick. Cloud County Highway Department quarried and crushed limestone for concrete aggregate and roadstone. Dimension limestone was prepared by Prickett, Inc. Fyfe Sand & Gravel Co. produced sand and gravel for building, paving, and fill uses.

Coffey.—Limestone was quarried and crushed for concrete aggregate, roadstone, riprap, and agstone by Nelson Bros. Quarries, Riddle Quarries, Inc., Jones Construction & Material Co., and Neosho Valley Rock Co. Gravel for paving and road maintenance was produced by Coffey County Highway Department. Coal was strip mined near Lebo by S. L. Rogers Coal Co. Crude petroleum output totaled 99,000 barrels, 2 percent more than that in 1962. Natural gas recovery doubled that of 1962, and totaled 200,000 cubic feet. U.S. Army Corps of Engineers continued construction of John Redmond dam and spillway. At yearend, the project was 90 percent complete. Scheduled completion date was February 1965.

Comanche.—Marketed production of natural gas was 7.5 billion cubic feet, an increase of 26 percent. Exploratory drilling resulted in discovery of Tuttle East gasfield. Output of crude petroleum increased 83 percent to 73,000 barrels. Gravel for paving was produced by various operators.

Cowley.—The county ranked 10th in petroleum production; output totaled nearly 3.8 million barrels, 13 percent less than that in 1962. Exploratory drilling resulted in discovery of Cooley oilfield. Apco Oil Corp. operated its refinery at Arkansas City. Natural gas recovery was more than 3.7 billion cubic feet, an increase of 35 percent over that of 1962. Dimension limestone was quarried by H. J. Born Stone Co., Silverdale Limestone Co., and John V. Elam. Crushed limestone for concrete aggregate, roadstone, and agstone was produced by Daniels Stone Co. Sand and gravel for building, paving, fill, and engine sand was produced by Carr Rock Products Co., George M. Myers, Inc., Andrews Sand & Gravel, Inc., Oxford Sand & Gravel Co., McFarland Gravel Co., Wilson Bros., and Cowley County Highway Department.

Crawford.—Crawford County ranked second in coal production. Two strip mines were operated by Clemens Coal Co. and one strip mine each by Cliff Carr Coal Co. and Joe E. Gobl Coal Co. Fire clay and miscellaneous clay were used to manufacture sewer pipe and stoneware by W. S. Dickey Clay Manufacturing Co. and Pittsburg Pottery Co., Inc. Petroleum output increased 55 percent to 63,000 barrels. Farlington oilfield was an important discovery during the year. Recovery of natural gas increased 161 percent to 65 million cubic feet.

Decatur.—Production of crude petroleum totaled 517,000 barrels, an increase of 3 percent over that of 1962. Building sand, fill sand, and paving gravel were produced by Morton Sand & Gravel Co., Meade County Highway Department, and Decatur County Highway Department.

Dickinson.—Limestone was quarried and crushed for concrete aggregate, roadstone, riprap, and agstone by Riddle Quarries, Inc., and Anderson-Oxandale. Crude petroleum production amounted to 48,000 barrels, an increase of 2 percent. Recovery of natural gas was 10 million cubic feet.

Doniphan.—George W. Kerford Quarry Co., West Lake Quarry & Material Co., Wolf River Limestone, Inc., Everett Quarries, Inc., and Doniphan County Highway Department quarried and crushed limestone for concrete aggregate, roadstone, and riprap. Gravel for paving and road maintenance was produced by Doniphan County Highway Department.

Douglas.—Clark Rock Quarry quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Sand and gravel for building, paving, and fill was produced by Holliday Sand & Gravel Co. and Bowersock Mills & Power Co. Crude petroleum output dropped 32 percent; secondary recovery operations supplied most of the production. Natural gas production totaled 24 million cubic feet. Cooperative Farm Chemicals Association, producer of ammonia, nitric acid, and fertilizers, completed expansion of its petrochemical complex at Lawrence.

Edwards.—Production of crude petroleum decreased for the third consecutive year; total output was 415,000 barrels. Natural gas output totaled 3 billion cubic feet. Bordewick, Britton, and McClanahan East gasfields were important discoveries in 1963. San Ore construction Co., Inc., and Kinsley Sand and Gravel Co. produced sand and gravel for building, paving, and fill uses.

Elk.—Concrete Materials Division, Martin-Marietta Corp., and Sedan Limestone Co. quarried and crushed limestone for concrete aggregate, roadstone, railroad ballast, and agstone. Crude petroleum production totaled 153,000 barrels, 11 percent less than in 1962. Recovery of natural gas increased 272 percent to 464 million cubic feet.

Ellis.—Ellis County ranked first in petroleum production and total value of mineral production. Crude petroleum production totaled 9.5 million barrels, 4 percent less than in 1962. Sand and gravel for building and paving was produced by Hunter Ready Mix Co., Inc., Larry F. Werth, Lewis C. Schmidtberger, and Rush County Highway Department. Aubel Asphalt Co. and Ellis County Highway Department quarried and crushed limestone for concrete aggregate and roadstone. Dimension limestone was prepared by Hays Cut Stone & Veneer.

Ellsworth.—Ellsworth County ranked first in production of natural gas liquids and rock salt, and seventh in total mineral production value. Northern Gas Products Co., subsidiary of Northern Natural Gas Co., began operating its natural gas liquids extraction plant at Bushton. The company had a 2-million-barrel natural gas liquids storage facility in a salt formation in the county.[7] Northern Helex

[7] Oil & Gas Journal. V. 61, No. 42, Oct. 21, 1963, p. 110.

Co., another subsidiary of Northern Natural Gas Co., operated its helium extraction plant adjacent to the natural gas liquids plant. Crude petroleum output totaled 1.6 million barrels, approximately the same as that in 1962. Gregory and Oxhide oilfields were important discoveries during the year. Natural gas production totaled 64 million cubic feet. Independence Salt Co. mined salt near Kanopolis. Sand and gravel for building, paving, and fill uses was produced by San Ore Construction Co., Inc., Walter Hoffman, Truhlar's Ready Mix Concrete, Stoppel Construction Co., and Ellsworth County Highway Department. Fire clay for building brick was mined by Acme Brick Co.

Finney.—The county ranked fifth in natural gas production; 52.9 billion cubic feet were recovered, 11 percent less than that in 1962. Output of crude petroleum increased 16 percent to over 2 million barrels. Northern Natural Gas Co. recovered natural gas liquids at its plant near Holcomb. Sand and gravel, mainly for building and paving, was produced by Smith Sand Co., Southwest Sand Co., Sam Alsop Construction Co., and Finney County Highway Department.

Ford.—Crude petroleum production was 25 percent less than that in 1962. Bucklin gasfield was an important discovery in 1963. Output of natural gas was 41 percent less than that in 1962. Skelly Oil Co. recovered natural gas liquids at its Minneola plant. Sand and gravel, mainly for building and paving, was produced by Dodge City Sand Co., Miller Sand & Gravel Co., Davis & Sons Sand Sales, and Ford County Highway Department.

Franklin.—Franklin County ranked fourth in value of clay production. Buildex, Inc., produced expanded shale lightweight aggregate at its plant near Ottawa; the crude shale was mined near the plant. Limestone was quarried and crushed for concrete aggregate, roadstone, and aglime by Fogle Quarry and Concrete Materials Division, Martin-Marietta Corp. Gravel for paving and road maintenance was produced by Franklin County Highway Department. Crude petroleum production decreased 22 percent to 262,000 barrels; natural gas output was 65 million cubic feet.

Geary.—Limestone was quarried and crushed for concrete aggregate, roadstone, riprap, and agstone by Walker Cut Stone Co., Anderson-Oxandale, and Bayer Construction Co. Dimension limestone was prepared by Junction City Stone Co. and Walker Cut Stone Co. Building and paving sand and gravel were produced by Junction City Sand & Gravel Co. and More Sand Co., Inc. Crude petroleum production totaled 1,000 barrels. Construction of major features of Milford Dam was 60 percent complete at yearend. Completion of the project is scheduled for 1966.

Gove.—Crude petroleum output totaled 83,000 barrels, an increase of 21 percent over that of 1962. Garvey Ranch oilfield was an important discovery in 1963. Building and paving sand and gravel were produced by Rod Bentley Sand & Gravel, Dave Bollinger, and Gove County Highway Department.

Graham.—Graham County ranked eighth in petroleum production; output decreased 4 percent to 5.2 million barrels. Kohart oilfield was

an important discovery in 1963. Anderson-Oxandale quarried and crushed limestone for concrete aggregate and roadstone. The company mined and crushed sandstone for riprap use by the State Highway Commission. Sand and gravel, mainly for building and paving, was produced by San Ore Construction Co., Inc., and Orville E. Clary.

Grant.—Grant County led in natural gas production, ranked second in natural gas liquids output, and fourth in total mineral value. Over 155.9 billion cubic feet of natural gas was produced, an increase of 36 percent over that of 1962. Four natural gasoline plants were in operation; two by Pan American Petroleum Corp. and one each by Hugoton Production Co. and Mobil Oil Co. Cities Service Helex, Inc., began operating its helium extraction plant at midyear; annual capacity of the plant is 600 million cubic feet. Cities Service Gas Co. completed the installation of two additional engines at its compressor station west of Ulysses, bringing total horsepower to 11,850. The engines were installed to offset declining wellhead pressures and to increase capacity. Carbon black was produced by Columbian Carbon Co. at Hickok. Assets of United Carbon Co. were sold to Ashland Oil & Refining Co. A small quantity of crude petroleum was produced in the county. Gravel for paving and road maintenance was produced by Grant County Highway Department.

Greenwood.—Secondary recovery operations yielded most of the 3.3 million barrels of crude petroleum; production decreased 10 percent. Natural gas production totaled over 65 million cubic feet, considerably greater than that in 1962. Limestone was quarried and crushed for concrete aggregate and roadstone by George M. Myers, Inc., and Greenwood County Highway Department.

Hamilton.—Production of natural gas increased 92 percent to 2.3 billion cubic feet. Crude petroleum production totaled 11,000 barrels, 17 percent more than that in 1962. Syracuse Sand & Gravel Co. and Hamilton County Highway Department produced sand for building, paving, and road maintenance.

Harper.—Crude petroleum output totaled 1.1 million barrels, 17 percent more than that in 1962. Marketed production of natural gas was 5.8 billion cubic feet, an increase of 5 percent. Building and paving sand and gravel were produced by Hi-Grade Sand Co. and Harper County Highway Department.

Harvey.—Output of crude petroleum increased 13 percent to 662,000 barrels. Natural gas production totaled slightly more than 1 billion cubic feet. Kansas Hydrocarbons Co. recovered natural gas liquids at its new plant near Burrton. Sand and gravel, mainly for building and paving, was produced near Burrton by Bryant Sand Co.

Haskell.—Output of crude petroleum totaled slightly less than 1.5 million barrels, 20 percent less than that in 1962. Nearly 44 billion cubic feet of natural gas was produced, compared with 39.4 billion cubic feet in 1962. Sand for paving and road maintenance was obtained by Haskell County Highway Department.

Hodgeman.—Almost 2 million barrels of crude petroleum was produced, an increase of 116 percent over that of 1962. Exploratory drilling resulted in five important oilfield discoveries—Eakin Northwest, Goebel East, Lippoldt, Mellecker, and Saw Log Creek South-

east. Sand for paving and road maintenance was produced by Hodgeman County Highway Department and Ness County Highway Department.

Jackson.—Gravel for paving and road maintenance was produced by G. W. Baker and Jackson County Highway Department. Anderson-Oxandale quarried and crushed limestone for concrete aggregate and roadstone. Crude petroleum output totaled slightly more than 2,400 barrels; no production was reported in 1962.

Jefferson.—Jefferson County ranked second in value of stone production. N. R. Hamm Quarry, Inc., and Roy Baker Quarry, Inc., quarried and crushed limestone for concrete aggregate, roadstone, riprap, and aglime. Land acquisition for the Perry Dam and Reservoir was started in 1963. Bid requests for construction were scheduled for 1964.

Jewel.—The county ranked fifth in value of stone produced. Limestone was quarried by Ideal Cement Co. and used for cement at its plant near Superior, Nebr.

Johnson.—Johnson County ranked fourth in value of stone production. Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Reno Construction Co., Union Construction Co., and Deitz-Hill Development Co. Building and paving sand, fill sand, filtration sand, and building gravel were produced by Builders Sand Co. and Holliday Sand & Gravel Co. Crude petroleum production totaled 30,000 barrels. Marketed production of natural gas increased 173 percent to 273 million cubic feet.

Kearny.—The county ranked fourth in natural gas production; over 77 billion cubic feet was produced. Natural gas liquids were recovered at the Colorado Interstate Gas Co. Lakin plant and at the Kansas-Nebraska Natural Gas Co. Deerfield plant. Output of crude petroleum approximated that of 1962. Sand and gravel for building, paving, and fill was produced by Popejoy Sand & Gravel Co., Smith Sand Co., and Kearny County Highway Department.

Kingman.—Almost 4 million barrels of crude petroleum was produced, a decrease of 10 percent from that of 1962. Production of natural gas increased 7 percent to 28.5 billion cubic feet. Nashville gasfield was an important discovery in 1963. Natural gas liquids were recovered at the Mobil Oil Co. Spivey plant and at the new Kansas Hydrocarbons Co. Cheney plant. Ray Wells and Kingman County Highway Department produced sand and gravel, mainly for building and paving.

Kiowa.—Crude petroleum output totaled 476,000 barrels, 21 percent less than that in 1962. Production of natural gas increased 22 percent to 12.9 billion cubic feet. Ursula Northeast gasfield was an important discovery during the year. Seacat Sand & Excavation Co. and Kiowa County Highway Department produced sand and gravel for building, paving, and road maintenance.

Labette.—Production of crude petroleum totaled 85,000 barrels, a decrease of 16 percent from that of 1962. Output of natural gas was double that of 1962 and totaled 130.5 million cubic feet. Limestone was quarried and crushed for concrete aggregate, roadstone, and riprap by Carr Rock Products Co., John J. Stark, and Labette County Highway Department.

Leavenworth.—Leavenworth Quarries and Concrete Materials Division, Martin-Marietta Corp., quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Missouri Valley Sand, Inc., produced sand for fill and other uses. Production of natural gas was 294 million cubic feet, 135 percent greater than that in 1962. Crude petroleum production was 9,300 barrels; no production was reported in 1962.

Lincoln.—Sandstone was quarried and crushed for concrete aggregate, roadstone, riprap, railroad ballast, and filter use by Quartzite Stone Co., Inc. C. W. Roweth Co. produced crushed limestone for riprap. Paving sand and gravel was produced by Material Producers, Inc. A small quantity of volcanic ash was produced by Ernest Hanzlicek.

Linn.—Crude petroleum production totaled 52,000 barrels, 4 percent more than in 1962. Waterflood projects accounted for a large part of total output. Natural gas production increased 161 percent, totaling 130.5 million cubic feet. Murray Limestone Products, Lee Giles Rock Co., and Wade Agricultural Lime Products quarried and crushed limestone for concrete aggregate, roadstone, and aglime. Linn County Highway Department produced gravel for paving and road maintenance.

Logan.—Siebert Sand Co. produced paving sand near Ness City. Logan County Highway Department obtained gravel for paving and road maintenance. No crude petroleum production was reported in 1963; 1,200 barrels was produced in 1962.

Lyon.—Crude petroleum output totaled 93,000 barrels, a decrease of 9 percent from that of 1962. Sand and gravel for building, paving, and road maintenance was produced by Wesley Parks and Lyon County Highway Department. Limestone was quarried and crushed for concrete aggregate, roadstone, riprap, and agstone by W. S. Jones Rock Co. and Jones Construction & Material Co.

Marion.—Crude petroleum production was 1.8 million barrels, 30 percent less than that in 1962. Production of natural gas was 7.3 billion cubic feet, 4 percent below 1962 output. Natural gas liquids were recovered by Rounds & Stewart Natural Gasoline Co., Inc., at its plant near Marion. Limestone was quarried and crushed for concrete aggregate, roadstone, agstone, and riprap by Riddle Quarries, Inc., The Walt Keeler Co., Inc., and Anderson-Oxandale.

Marshall.—Bestwall Gypsum Co. mined gypsum near Blue Rapids and produced plaster and plaster products. Sand and gravel, mainly for building and paving, was produced by Blue River Sand & Gravel Co., C. V. Garrett, Heinzelman Construction Co., and Marshall County Highway Department. Hopper Bros. Quarries, Bayer Construction Co., G. W. Baker, and Anderson-Oxandale quarried and crushed limestone for concrete aggregate, roadstone, and aglime.

McPherson.—Crude petroleum production totaled 2.7 million barrels, a decrease of 17 percent from that of 1962. Production of natural gas increased 40 percent to 315 million cubic feet. Buildex, Inc., mined shale and produced expanded-shale lightweight aggregate at its plant near Marquette. McPherson County Highway Department produced gravel for paving and road maintenance. National Cooperative Refinery Association operated its petroleum refinery at McPherson.

Meade.—Output of crude petroleum decreased 7 percent to 712,000 barrels. Production of natural gas was slightly less than 16 billion cubic feet. Crooked Creek and Meyers gasfields were important discoveries during the year.

Miami.—Production of crude petroleum totaled 241,000 barrels, a decrease of 20 percent from that of 1962. Waterflood projects accounted for most of the production. Natural gas output was 65 million cubic feet, compared with 20 million cubic feet in 1962. L. W. Hayes, Inc., and White-Hruska Quarry, Inc., quarried and crushed limestone for concrete aggregate, roadstone, and agstone.

Mitchell.—Sand and gravel for building, paving, and fill were produced by Ed Hartman and Haigh Sand & Gravel from deposits near Beloit.

Montgomery.—Universal Atlas Cement Division of U.S. Steel Corp. mined shale and limestone for use in manufacturing portland and masonry cements. Limestone was quarried and crushed for concrete aggregate, roadstone, agstone, and riprap by Nelson Bros. Quarries, H & S Rock Co., Carr Rock Products, Inc., and Harry Keith. Cherryvale Zinc Co. began an experimental project on production of metal oxide for industrial use. Output of crude petroleum was 9 percent less than that in 1962; secondary recovery projects accounted for about half of total oil production. Natural gas production was 816 million cubic feet, 133 percent above 1962 output. Cooperative Refinery Association operated its petroleum refinery at Coffeyville.

Morris.—Crude petroleum production totaled 404,000 barrels, a decrease of 7 percent from that of 1962. Output of natural gas decreased 17 percent to 296 million cubic feet. Limestone was quarried and crushed for concrete aggregate, roadstone, riprap, and aglime by Anderson-Oxandale and Riddle Quarries, Inc. Gravel for paving and road maintenance was produced by Metcalf Fill Dirt & Gravel, Morris County Highway Department, and Lyon County Highway Department.

Morton.—Morton County ranked third in natural gas production with 82.5 million cubic feet. Crude petroleum output increased 5 percent to more than 2.1 million barrels. Anadarko Production Co. recovered natural gas liquids at its Interstate plant near Elkhart.

Nemaha.—Anderson-Oxandale Co., Marcy Sand & Gravel, Justin Rottinghaus, and Uhlig & Reise produced sand and gravel for building, paving, and other uses. G. W. Baker quarried and crushed limestone for concrete aggregate and roadstone. Crude petroleum production totaled almost 6,000 barrels, 17 percent less than that in 1962.

Neosho.—Neosho County ranked second in portland and masonry cement production and sixth in value of stone production. Ash Grove Lime & Portland Cement Co. quarried limestone, sandstone, and shale for manufacture of cement. Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Harry Byers & Sons, Inc., O'Brien Rock Crusher, and Neosho County Highway Department. Building, paving, and fill sand and gravel were produced by Hy-Grade Construction Materials at St. Paul. Production of crude petroleum approximated that of 1962. A major part of crude petroleum production was recovered by water-flooding methods. Mid-America Refining Co., Inc., operated its petroleum refinery at Chanute.

747-416—64——30

Output of 369 million cubic feet of natural gas was more than triple that of 1962.

Ness.—Crude petroleum production increased 43 percent to 1.1 million barrels. Buda, McDonald, Sunshine, and Wunder oilfields were important discoveries during the year. Sand for paving and road maintenance was produced by Ness County Highway Department.

Norton.—Output of crude petroleum totaled 692,000 barrels, 11 percent below that of 1962. Sandstone was quarried and crushed for concrete aggregate, roadstone, and riprap by Van Buskirk Construction Co. Anderson-Oxandale produced crushed limestone for concrete aggregate and roadstone. Gravel for paving and road maintenance was produced by Norton County Highway Department. Wyandotte Chemical Corp. mined and prepared volcanic ash near Calvert.

Construction of Norton Reservoir, a Bureau of Reclamation project, was 53 percent complete at yearend. Closure was expected in 1964.

Osage.—Osage County ranked fourth in coal production. Coal was mined underground by Bell Coal Co. and strip mined by Johnson Coal Co. Limestone was quarried and crushed by Osage County Highway Department.

Osborne.—Crude petroleum production decreased 21 percent to 46,000 barrels. Gravel and crushed limestone were produced by Osborne County Highway Department for paving and road maintenance. Boyd Craemer produced gravel for paving near Portis. The Glen Elder project of Bureau of Reclamation was about 2 percent complete at yearend; expected completion date is 1969.

Pawnee.—Output of crude petroleum totaled slightly more than 1 million barrels, 4 percent less than that in 1962. Production of natural gas decreased 15 percent to 2 billion cubic feet. Eddy gasfield was an important discovery in 1963. Sand and gravel, mainly for building and paving, was produced by Johnson Sand & Gravel Co., Larned Sand & Gravel Co., and Pawnee County Highway Department.

Phillips.—Output of crude petroleum approximated that of 1962. Cooperative Refinery Association operated its petroleum refinery at Phillipsburg. Limestone for concrete aggregate and roadstone was quarried and crushed by Anderson-Oxandale. Phillips County Highway Department obtained sand for paving and road maintenance.

Pottawatomie.—Dimension limestone was prepared by Bayer Stone, Inc. Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Bayer Construction Co., Inc., Anderson-Oxandale, and Concrete Materials Division, Martin-Marietta Corp. Sand and gravel, mainly for building and paving, was produced by Wamego Sand Co. and Anderson-Oxandale Co.

Pratt.—Production of crude petroleum totaled 1.4 million barrels, a decrease of 11 percent from that of 1962. Natural gas output totaled 2.9 billion cubic feet, approximately the same as that of 1962. Gereke West and Pratt Airport gasfields were important discoveries during the year. Sand for building and paving was produced by Mrs. Blanche Hogard, Whitfield Sand & Gravel, Miller Sand & Gravel Co., and Pratt County Highway Department.

Rawlins.—Crude petroleum output approximated that of 1962, totaling 766,000 barrels. Atwood Sand & Rock Co. produced crushed opal (miscellaneous stone) for concrete aggregate, roadstone, and roofing granules, and sand for building and paving. Konkrete Block Co. quarried and crushed opal for concrete aggregate. Gravel for paving and road maintenance was obtained by Rawlins County Highway Department. Anderson-Oxandale quarried and crushed limestone for concrete aggregate and roadstone.

Reno.—Reno County ranked first in salt production. Evaporated salt from brine wells was produced by the Carey Salt Co., Morton Salt Co., and the Barton Salt Co. Rock salt was mined by the Carey Salt Co. Sand and gravel, mainly for building and paving, was produced by J. E. Steele Sand & Gravel, Shears Sand Plant, Hoskinson Sand & Gravel Co., Gravel Products, Inc., Haven Sand Co., Fountain Sand Pit, and the city of Hutchinson. Late in the year, Cities Service Oil Co. began recovering natural gas liquids at its new fractionation plant in Hutchinson. A new 180-mile pipeline from Ulysses delivers a deethanized feedstock for the 650,000-gallon-per-day plant. Crude petroleum output, 975,000 barrels, approximated that of 1962. Natural gas production increased 15 percent to 3.3 billion cubic feet.

Republic.—John H. Alsop Sand Co. and Reece-Johnson, Inc. produced sand and gravel near Scandia, mainly for building and paving. Republic County Highway Department produced sand and quarried and crushed limestone for concrete aggregate and road maintenance.

Rice.—The county ranked second in value of salt production and sixth in petroleum output. American Salt Co. produced evaporated salt from brine wells and mined rock salt near Lyons. Crude petroleum production increased 20 percent. Output of natural gas increased 59 percent to 500 million cubic feet. Lyons West oilfield was an important discovery in 1963. Riddle Quarries, Inc., and Rice County Highway Department quarried and crushed limestone for concrete aggregate, roadstone, aglime, and riprap. Sand and gravel, mainly for building and paving, was produced by Tobias Wright & Birchenough, Inc., Rock Hill Stone & Gravel Co., Inc., and Arensman Sand & Gravel Co.

Riley.—Bayer Construction Co., Inc., Riddle Quarries, Inc., Anderson-Oxandale, and U.S. Army Corps of Engineers at Fort Riley quarried and crushed limestone for concrete aggregate and roadstone. Dimension limestone was prepared by Bayer Stone, Inc. Building sand and paving sand were produced by Walters Sand Co., Inc. Tuttle Creek Dam and Reservoir was dedicated during the year. Crude petroleum production decreased 4 percent to 211,000 barrels.

Rooks.—Rooks County ranked fifth in production of crude petroleum, nearly 5.6 million barrels. Building sand was recovered from deposits near Alton by Howard Covert.

Rush.—Volume of shipments of helium with a purity of 99.995 percent or greater from the Bureau of Mines plant at Otis increased 9 percent. Crude petroleum production totaled 358,000 barrels, 5 percent less than that in 1962. Output of natural gas increased 8 percent to nearly 1.8 billion cubic feet. Rush County Highway Department produced sand for paving and road maintenance.

Russell.—Russell County ranked third in petroleum production and third in total mineral value. Crude petroleum output was nearly 8.5 million barrels, an increase of 6 percent. Production of natural gas increased 12 percent to 439 million cubic feet. San Ore Construction Co., Inc., produced paving sand and paving gravel. U.S. Army Corps of Engineers closed the Wilson Dam in September, a year ahead of schedule. Construction of the embankment, spillway, and outlet works was 80 percent completed at yearend.

Saline.—The county ranked third in value of sand and gravel production. Central Kansas Sand, Inc., and Salina Sand Co., Inc., produced sand and gravel, mainly for building and paving. Output of crude petroleum decreased 7 percent to 745,000 barrels. Pihl oilfield was an important discovery in 1963.

Scott.—Crude petroleum production totaled 53,000 barrels, 16 percent below that of 1962. Century Refining Co. operated its petroleum refinery at Shallow Water. Output of natural gas was 23 million cubic feet; no production was reported in 1962.

Sedgwick.—Sedgwick County ranked second in salt and sand and gravel production and fourth in recovery of natural gas liquids. Fifteen commercial sand and gravel producers and one Government-and-contractor producer reported production in 1963. Leaders were Superior Sand Co., Inc., Miles Sand, Inc., Dolese Bros. Co., Bentley Sand Co., and Wichita Big River Sand Co. Building, paving, fill, and blast sand, and building, paving, and fill gravel were produced. Frontier Chemical Co. pumped brine from wells to manufacture chlorine and caustic soda; the company completed construction and began operating its ammonia plant. Natural gas liquids were recovered by Cities Service Oil Co. at its Wichita plant. Output of crude petroleum totaled 2.5 million barrels, an increase of 5 percent over that of 1962. Derby Refining Co. operated its petroleum refinery at Wichita. Production of natural gas totaled 65 million cubic feet; none was reported in 1962. Dodson Manufacturing Co., Inc., of Wichita exfoliated vermiculite, using crude vermiculite purchased from Zonolite Co. in Libby, Mont. Construction of Cheney Dam and Reservoir, a Bureau of Reclamation project, continued ahead of schedule.

Seward.—The county ranked third in natural gas liquids output. National Helium Corp. began operating its helium extraction plant near Liberal at midyear. Natural gas liquids were recovered by National Helium Corp., Anadarko Production Co., and Northern Natural Gas Co. Production of crude petroleum decreased 4 percent to 1.2 million barrels. Natural gas production totaled 27.4 billion cubic feet, a decrease of 34 percent. Arkalon West and March gasfields were important discoveries during the year. Sand and gravel, mainly for building and paving, was produced by Carlisle Sand Products, Inc., and Seward County Highway Department.

Shawnee.—Shawnee County ranked fourth in value of sand and gravel produced. Kansas Sand Co., Inc., Victory Sand and Stone Co., Consumers Sand Co., Barnes Sand & Gravel Co., and Topeka Sand Co. produced building, paving, and fill sand and gravel, engine sand, and other industrial sands. Limestone was quarried and crushed for concrete aggregate, and roadstone by Henry C. Luttjohann, Inc.,

Netherland Stone Co., and Concrete Materials Division, Martin Marietta Corp.

Sherman.—Output of crude petroleum totaled 44,000 barrels, 30 percent less than that in 1962. Walt Rhoads Sand & Gravel, Murphy Excavating Co., and Sherman County Highway Department produced building and paving sand and gravel.

Smith.—Limestone was quarried and crushed for concrete aggregate and roadstone by Anderson-Oxandale and Smith County Highway Department.

Stafford.—Stafford County ranked seventh in crude petroleum production; output totaled 5.3 million barrels, 10 percent below that of 1962. Rychlec oilfield and Emerson West gasfield were important discoveries during the year. Natural gas production decreased 14 percent to 3 billion cubic feet. Sand and gravel for building, paving, and road maintenance was produced by Partin Sand & Gravel Co. and Stafford County Highway Department.

Stanton.—The county ranked 10th in natural gas output; marketed production increased 2 percent to 22 billion cubic feet. Crude petroleum production totaled 17,000 barrels, an increase of about 1,000 barrels.

Stevens.—Stevens County ranked second in output of natural gas; production increased 2 percent to 153.7 billion cubic feet. Production of crude petroleum totaled 432,000 barrels, an increase of 8 percent over that of 1962. Gooch gasfield was an important discovery in 1963.

Sumner.—Crude petroleum production decreased 2 percent to 3 million barrels. Output of natural gas totaled 527 million cubic feet, an increase of 64 percent. Corastone gasfield was an important discovery during the year. Builders Sand Co., Mulvane Sand Co., Inc., and Sumner County Highway Department produced sand and gravel for building, paving, and road maintenance.

Thomas.—Siebert Sand Co., Inc., Purma Drag Line Co., Hubbard Sand & Gravel, and Thomas County Road Department produced sand and gravel for building, paving, fill, and road maintenance.

Trego.—Output of crude petroleum totaled 1.6 million barrels, approximately the same as that in 1962. Muhlheim oilfield was an important discovery during the year. Building, paving, and fill sand were produced by Siebert Sand Co., Inc., Smith Sand Co., and Raymond Stanton. Trego County Highway Department obtained gravel for paving and road maintenance. Limestone was quarried and crushed by Aubel Asphalt Co. for use as concrete aggregate.

Wabaunsee.—Crude petroleum production decreased 3 percent to 250,000 barrels. Bayer Construction Co. quarried and crushed limestone for concrete aggregate and roadstone.

Wallace.—Diatomaceous marl was quarried by De Lore Division, National Lead Co., south of Edson. Principal uses were as paint filler and whiting material. Wallace County Highway Department produced gravel for paving and road maintenance.

Wichita.—Crude petroleum production totaled slightly over 1,000 barrels, a decrease of 22 percent from that of 1962. Gravel for paving was produced by Willis Reimer. Wichita County Highway Department obtained sand for paving and road maintenance.

Wilson.—Wilson County ranked fourth in production of portland cement. Victor Portland Cement Division, General Portland Cement Co., mined shale and limestone for manufacture of portland and masonry cements. Excelsior Brick Co. and Acme Brick Co. mined shale for building brick. Limestone was quarried and crushed for concrete aggregate, roadstone, aglime, and riprap by Carr Rock Products Co. and Benedict Rock & Lime Co. Wilson County Highway Department obtained gravel for paving and road maintenance. Crude petroleum output approximated that in 1962; secondary recovery projects accounted for most of the output. Production of natural gas increased to 497 million cubic feet, compared with 134 million cubic feet in 1962. American Oil Co. operated its petroleum refinery at Neodesha.

Woodson.—Output of crude petroleum totaled 824,000 barrels, a decrease of approximately 1 percent. Waterflooding supplied a large part of the output. Natural gas production totaled 1.2 million cubic feet.

Wyandotte.—Wyandotte County ranked first in stone and sand and gravel output, third in portland cement production, and fifth in value of clay production. Lone Star Cement Corp. obtained limestone and shale for manufacturing portland and masonry cements at Bonner Springs. Limestone was quarried and crushed for concrete aggregate, roadstone, riprap, and flux by Thompson-Strauss Quarries and J. A. Tobin Construction Co. Sand and gravel, mainly for building and paving, was produced by Holliday Sand & Gravel Co., Stewart Sand & Material Co., Builders Sand Co., American Sand Co., Superior Sand & Gravel Co., Peck-Woolf Sand & Material Co., and Kaw Valley Sand Co., Inc. Crude perlite, mined in Western States, was expanded by Lite Weight Products, Inc., at its Kansas City plant for use as building material.

Phillips Petroleum Co. operated its petroleum refinery at Kansas City; the company produced rubber extender and process oils, using petroleum fractions as feedstock. Reichold Chemicals, Inc., produced phenol-formaldehyde resins, polyvinyl acetate emulsions, and formaldehyde at its chemical plant in Kansas City.

The Mineral Industry of Kentucky

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Kentucky for collecting information on all minerals except fuels.

By Harold L. Riley [1] and Preston McGrain [2]

MINERAL production value in Kentucky in 1963 increased 9 percent but was 14 percent below that of 1948, the record year. New records were established for masonry and portland cements, miscellaneous clay, crushed limestone, and sand and gravel. The value of coal output increased 9 percent, and the total tonnage increased 12 percent. Among the States, Kentucky ranked second in production of bituminous coal, ball clay, and fluorspar.

Coal mining dominated the Kentucky mineral industry and supplied 68 percent of the total value for both 1962 and 1963. Leading companies, based on value of production, were Peabody Coal Co., Nashville Coal Co., Pittsburgh & Midway Coal Co., Bethlehem Mines, Inc., and River Queen Coal Co.

TABLE 1.—Mineral production in Kentucky [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	4,097	$36	5,812	$85
Clays [2]—thousand short tons	936	2,158	984	2,397
Coal (bituminous)—do	69,212	270,875	77,350	295,743
Fluorspar—short tons	33,830	1,492	35,072	1,537
Gem stones	(3)	(4)	(3)	(4)
Lead (recoverable content of ores, etc.)—short tons	743	137	831	179
Natural gas—million cubic feet	70,241	17,419	74,634	17,838
Petroleum (crude)—thousand 42-gallon barrels	17,789	52,478	[5] 19,047	[5] 55,617
Sand and gravel—thousand short tons	6,137	5,378	6,480	6,071
Silver (recoverable content of ores, etc.)—troy ounces	1,410	2	1,515	2
Stone—thousand short tons	19,472	27,682	24,689	34,571
Zinc (recoverable content of ores, etc.)—short tons	1,172	270	1,461	336
Value of items that cannot be disclosed: Cement, ball clay, and natural gas liquids		20,609		20,370
Total		[6] 398,536		434,746

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes ball clay, which is included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Less than $500.
[5] Preliminary figure.
[6] Revised figure.

[1] Mining engineer, Area II Mineral Resource Office, Bureau of Mines, Knoxville, Tenn.
[2] Assistant state geologist, Kentucky Geological Survey, Lexington, Ky.

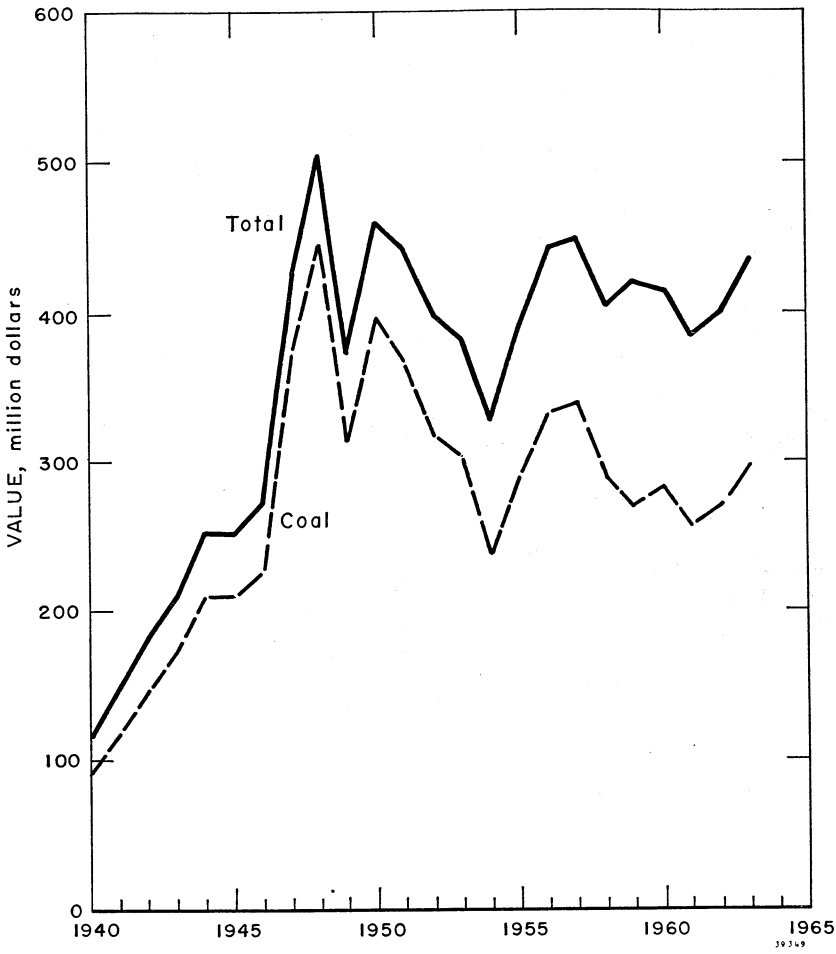


FIGURE 1.—Value of coal and total value of mineral production in Kentucky, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Trends and Developments.—Island Creek Coal Co., by purchase of stock, acquired control of West Kentucky Coal Co. and its subsidiary, Nashville Coal Co. Peabody Coal Co. announced plans to open a new strip mine in Ohio County and to use an 85-cubic-yard walking dragline to move up to 140 feet of overburden. The coal will be shipped by barge. Bethlehem Mines, Inc., announced plans to open a new underground mine near Jenkins.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$411,458	1958	$405,300
1953	388,061	1959	429,146
1954	354,028	1960	429,407
1955	402,440	1961	401,868
1956	458,338	1962	423,142
1957	438,939	1963	461,963

Alpha Portland Cement Co. acquired 1,300 acres of land 7 miles east of Maysville to supplement its reserves of limestone for manufacture of portland cement. Marquette Cement Co. constructed at Paducah a $1 million, 62,000-barrel-capacity, cement storage facility. Cement was shipped by barge from a plant at Cape Girardeau, Mo.

Armco Steel Corp. at Ashland lighted a new blast furnace capable of producing 3,300 tons of pig iron per day. Acme Steel Co. planned a $4 million expansion and remodeling program at the Newport plant. Pittsburgh Metallurgical Co., a division of Air Reduction Co., announced plans for a $6.5 million expansion program, including two 25,000-kilowatt submerged arc furnaces, at its ferroalloy plant at Calvert City.

General Shale Products Corp. completed a tunnel kiln with a capacity of 26 million brick per year at the Coral Ridge plant at Fairdale.

Legislation and Government Programs.—The Federal Geological Survey published Bulletin 1120 entitled "Coal Reserves of Eastern Kentucky." This publication was prepared in cooperation with the Kentucky Geological Survey and the Federal Bureau of Mines. The publication estimates reserves of 33 billion tons of coal in eastern Kentucky.

The Markland Locks and Dam on the Ohio River near Warsaw were dedicated. The dam creates a 93-mile pool and eliminates five small dams and locks. One of the new Markland Locks is 1,200 feet long and 110 feet wide, which eliminates the necessity of time-consuming double lockages.

The Federal Geological Survey and the Kentucky Geological Survey continued the cooperative program of mapping the geology of the State on 7.5-minute quadrangles.

Water.—During 1963 the Bureau of Mines canvassed the mineral producers in 1963 for water usage in 1962. Bituminous coal preparation plants used the major portion of new or added water and recirculated water. Of the total water used, coal plants used 86 percent, crude petroleum used 10 percent, the sand and gravel industry used 3 percent, and nonmetal mines and mills used 1 percent.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Industry	New water	Recirculated water	Total water use
Quarries and mills	4		4
Coal (bituminous)	8,096	14,623	22,719
Nonmetal mines and mills	321	9	330
Sand and gravel mines	766	19	785
Petroleum	2,264	283	2,547
Total	11,451	14,934	26,385

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Production of coal increased 12 percent but was 8 percent below the 1947 record. Bituminous coal was mined at 1,993 mines in 42 counties, compared with 1,934 mines in 42 counties in 1962. Leading counties were Muhlenberg, Pike, Hopkins, and Harlan. Leading producing companies on the basis of tonnage were Peabody Coal Co., Pittsburg & Midway Coal Co., River Queen Coal Co., and West Kentucky Coal Co.

In the eastern Kentucky coalfield 1,894 mines in 31 counties produced 41,635,000 tons, compared with 1,840 mines, 30 counties, and 37,157,000 tons in 1962. Average production per mine increased from 20,200 tons to 22,000 tons. Underground mines produced 84 percent, auger mines 9 percent, and strip mines 7 percent of the total. Shipments were 84 percent by rail or water and 16 percent by truck. Captive tonnage was 15 percent of the total.

Equipment used at 1,721 underground mines included 1,215 cutting machines, which cut 77 percent of the tonnage; 1,851 power drills, which drilled 85 percent of the tonnage; 305 mobile loading machines, which loaded 44 percent of the tonnage; 50 continuous-mining machines, with 10 mobile loaders used in conjunction, which produced 12 percent of the tonnage; and 40 hand-loaded conveyors upon which was loaded 1 percent of the tonnage. Other equipment comprised 822 locomotives, 635 shuttle cars, 576 shuttle buggies, and 128 gathering conveyors.

Equipment used at 76 strip mines included 109 power shovels, 4 draglines, 107 bulldozers, 16 power drills, and 198 trucks. An estimated 18,598,000 cubic yards of overburden was removed.

Equipment used at 97 auger mines included 101 coal recovery augers, 6 power shovels, 73 bulldozers, 2 carryall scrapers, 5 power drills, and 176 trucks.

Of the total coal production from the eastern Kentucky field, 38 percent was cleaned at 42 cleaning plants, 25 percent was crushed, and 9 percent was treated with oil.

In the western Kentucky coal field, 99 mines in 11 counties produced 35,716,000 tons, compared with 94 mines, 12 counties, and 32,055,000 tons in 1962. Average production per mine increased from 341,000 to 361,000 tons. Underground mines produced 35 percent,

auger mines less than 1 percent, and strip mines 64 percent of the total. Shipments were 88 percent by rail or water and 12 percent by truck. All coal was sold on the open market.

Equipment used at 57 underground mines included 106 cutting machines, which cut 98 percent of the tonnage; 117 power drills, which drilled 99 percent of the tonnage; 96 mobile loading machines, which loaded 97 percent of the tonnage; and 3 continuous-mining machines, which mined 2 percent of the tonnage. Other equipment included 77 locomotives, 206 shuttle cars, and 71 gathering conveyors.

Equipment used at 40 strip mines included 89 power shovels, 30 draglines, 100 bulldozers, 45 power drills, and 201 trucks. An estimated 181 million cubic yards of overburden was excavated.

Equipment used at two auger mines included two coal recovery augers and one power drill.

Thirty-two cleaning plants cleaned 73 percent of the coal produced; 46 percent was crushed, and 13 percent was treated with oil or calcium chloride.

TABLE 4.—Coal (bituminous) production, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Bell	1,848,368	$7,315,288	1,394,108	$4,301,127
Boyd	56,149	157,820	56,846	205,798
Breathitt	602,521	3,514,947	252,405	1,288,834
Butler	183,547	762,771	191,829	797,188
Carter	24,432	122,160	29,500	99,710
Christian	69,799	361,964	58,659	291,110
Clay	1,065,391	4,077,350	1,283,379	4,981,929
Clinton	5,301	25,285	4,400	20,988
Daviess	1,062,050	2,770,291	848,679	2,202,700
Elliott	15,989	54,943	14,895	55,856
Floyd	3,746,688	20,528,914	4,364,606	24,051,970
Grayson	1,600	5,568		
Greenup			3,000	14,850
Hancock	3,205	11,153	26,126	84,648
Harlan	5,528,165	28,745,732	5,698,200	28,877,010
Henderson	278,109	822,244	149,510	453,015
Hopkins	10,330,308	36,177,347	11,161,795	38,435,234
Jackson	27,369	136,403	53,628	262,144
Johnson	179,992	602,973	236,758	797,874
Knott	1,968,636	6,232,009	2,451,884	6,804,875
Knox	279,893	934,546	398,493	1,299,957
Laurel	107,286	380,213	176,344	507,319
Lawrence	16,793	67,896	35,281	128,660
Lee	49,889	202,513	80,067	300,251
Leslie	1,805,170	6,931,853	2,259,736	9,257,212
Letcher	5,064,122	25,366,230	5,251,255	24,510,717
Magoffin	44,419	133,257	112,935	338,876
Martin	68,550	312,588	134,010	611,086
McCreary	360,322	1,268,606	332,796	1,244,657
McLean	73,638	211,545	65,292	178,525
Morgan	39,611	158,444	31,804	144,681
Muhlenberg	13,646,757	44,693,585	16,203,861	51,686,205
Ohio	3,238,664	10,721,872	3,445,061	11,190,357
Owsley	2,400	10,944	4,000	18,240
Perry	3,474,150	14,531,156	3,663,994	14,386,452
Pike	9,946,417	37,555,473	12,459,052	49,721 521
Pulaski	88,300	386,280	134,938	369,175
Rockcastle	10,000	33,020	5,660	22,443
Union	2,563,902	10,098,614	3,208,293	12,255,306
Wayne	1,800	8,118	2,580	11,042
Webster	603,298	1,641,389	356,494	950,688
Whitley	718,471	2,749,211	698,232	2,523,811
Wolfe	10,548	52,740	10,066	59,396
Total	69,212,019	270,875,255	77,350,451	295,743,437
Earliest record to date	2,843,333,000	(1)	2,921,183,000	(1)

[1] Data not available.

Coke.—Two companies produced coke in Boyd and Marshall Counties; Allied Chemical Corp., and New York Mining & Manufacturing Co.

Natural Gas.—Marketed production of natural gas increased 6 percent but was 23 percent below the 1947 record.

Natural Gas Liquids.—*Natural Gasoline.*—Production of natural gasoline decreased 21 percent.

LP Gases.—Production of liquefied-petroleum (LP) gases decreased 5 percent.

Petroleum.—Production of crude petroleum increased 7 percent but was 30 percent below the record established in 1959. Leading producing counties were Henderson, Lee, and Union, compared with Henderson, Daviess, and Lee in 1962. Henderson County produced more than 4 million barrels. Daviess, Hopkins, Lee, Union, and Webster Counties produced more than 1 million barrels each.

New discoveries and development operations, particularly in western Kentucky, and secondary-recovery projects of waterflooding offset the decline that affects normal production rates.

A total of 2,508 wells were drilled in 1963; 1,045 were completed as oil wells, 156 were completed as gas wells, 248 were water injection wells for secondary recovery, 31 were injection wells for gas storage, and 1,028 were dry holes.

Hopkins County produced over 1 million barrels more than in 1962. This increase was due to the discovery of new pools such as Hanson West, Richland, Sugar Creek, and Morton's Gap and to the development of the Hanson pool discovered in 1962.

Oil production in Lee County continued at a high level owing to successful waterflooding of older pools.

In central Kentucky, Metcalfe County experienced the most active exploration with 304 wells drilled during 1963. Production was from reef-type limestone of the Fort Payne formation of Mississippian age at an average depth of 400 to 450 feet. Initial production of 20 to 25 barrels per day per well has been common.

The Kentucky Geological Survey has published individual oil and gas maps for the Hanson, Slaughters, and East Fork Quadrangles.

TABLE 5.—Crude petroleum production, by counties

County	1962		1963[1]	
	Barrels	Value	Barrels	Value
Adair			76	$222
Allen	116,231	$342,765	83,486	243,779
Barren	43,240	127,515	29,962	87,489
Bath	5,355	15,792	5,123	14,959
Bell			260	759
Boyd	580	1,710	273	797
Breathitt	111,113	327,672	78,662	229,698
Breckinridge	118,349	349,011	74,910	218,737
Butler	347,435	1,024,586	229,629	670,517
Casey	34,263	101,042	15,247	44,521
Christian	935,971	2,760,178	593,137	1,731,960
Clinton	125,064	368,814	86,631	252,963
Crittenden	163	481	171	499
Cumberland	48,419	142,788	43,706	127,622
Daviess	1,749,337	5,158,795	1,646,064	4,806,507
Edmonson	807	2,380	1,015	2,964
Elliott	64,201	189,329	50,175	146,511
Estill	178,494	526,379	172,436	503,513
Floyd	15,394	45,397	17,335	50,618
Garrard	51	150		
Grayson	61	180		
Green	466,101	1,374,532	295,405	862,583
Hancock	255,291	752,853	214,103	625,180
Hardin	2,662	7,850	1,669	4,873
Hart	37,337	110,107	33,851	98,845
Henderson	[2] 3,492,322	[2] 10,317,094	4,240,540	12,382,138
Hopkins	270,585	797,955	1,348,675	3,938,131
Jackson	1,193	3,518	898	2,622
Johnson	184,591	544,359	284,361	830,334
Knott	15,168	44,730	13,453	39,283
Knox	1,795	5,294	1,707	4,984
Laurel	1,074	3,167	355	1,037
Lawrence	408,758	1,205,427	501,252	1,463,656
Lee	1,709,775	5,042,126	1,904,814	5,562,057
Leslie	3,944	11,631	2,891	8,442
Letcher	9,663	28,496	8,648	25,252
Lincoln	7,820	23,061	2,545	7,431
Logan	898	2,648	1,410	4,117
Magoffin	1,021,787	3,013,250	966,705	2,822,778
Martin	19,937	58,794	17,288	50,481
McCreary	16,936	49,944	9,133	26,668
McLean	835,979	2,465,303	810,813	2,367,574
Meade	74	218		
Menifee	517	1,525	1,207	3,524
Metcalfe	190,180	560,841	270,385	789,524
Monroe	109	322	2,248	6,564
Morgan	738	2,176	938	2,739
Muhlenberg	685,430	2,021,333	512,755	1,497,245
Ohio	940,609	2,773,856	932,501	2,722,903
Owsley	1,188	3,504	883	2,578
Perry	4,668	13,766	3,093	9,032
Pike	44,131	130,142	38,930	113,676
Powell	264,140	778,949	211,406	617,306
Russell	5,429	16,010	4,497	13,131
Simpson	11,086	32,693	7,675	22,411
Taylor	10,817	31,900	775	2,263
Todd	7,323	21,596	4,431	12,939
Union	1,555,234	4,586,385	1,707,414	4,985,649
Warren	44,762	132,003	43,098	125,846
Wayne	26,450	78,001	19,705	57,539
Webster	1,283,799	3,785,923	1,449,248	4,231,804
Whitley	29,303	86,415	26,447	77,225
Wolfe	24,869	73,339	20,550	60,006
Total	[2] 17,789,000	[2] 52,478,000	19,047,000	55,617,000
Earliest record to date	[2] 453,331,000	[2] 1,044,044,000	472,378,000	1,099,661,000

[1] Preliminary figures.
[2] Revised figures.

Source: Kentucky Geological Survey.

NONMETALS

Barite.—Mafluor Corp. mined crude barite in Crittenden County for oil well drilling.

Cement.—Kosmos Portland Cement Co. operated the Kosmosdale plant throughout 1963. Shipments of portland cement increased 11 percent above the previous high established in 1962. Shipments of masonry cement increased 13 percent and were 13 percent above the previous (1959) record. Raw materials used in portland cement included limestone (77 percent), miscellaneous clay (19 percent), gypsum (3 percent), and iron ore (1 percent).

Clays.—*Ball Clay.*—Kentucky ranked second in the United States in ball clay production. Kentucky-Tennessee Clay Co. and Old Hickory Clay Co. mined ball clay at three mines in Graves County for whiteware, refractories, and other uses.

Fire Clay.—Twelve companies mined fire clay at 27 mines in 4 counties for firebrick and block, floor and wall tile, heavy clay products, and fire clay mortar. Leading producers were General Refractories Co., Davis Fire Brick Co., and Hensley Mining Co., Inc. Production increased 8 percent but was 57 percent below the 1951 record. Total production was 211,000 tons valued at $1,388,000.

Miscellaneous Clay.—Thirteen companies mined miscellaneous clay at 14 mines in 9 counties for heavy clay products, lightweight aggregate, and cement. Leading producers were Kenlite Division of Kentucky Light Aggregates, Inc., Kosmos Portland Cement Co., and Big Run Coal & Clay Co., Inc. Production increased 4 percent above the high established in 1962. Total production was 772,000 tons valued at $1,009,000.

Fluorspar.—In Livingston, Crittenden, and Caldwell Counties fluorspar was mined for use in manufacturing hydrofluoric acid, steel, ceramics, and iron foundries. Leading producers were Calvert City Chemical Co. (Dyers Hill mine) and Nancy Hanks Mines, Inc. (Nancy Hanks mine). Total marketable production was 35,000 tons valued at $1,537,000. Marketable production increased 4 percent but was 76 percent below the 1941 record. Total cumulative production from earliest records to date was 2,982,000 tons.

Gem Stones.—Majors Rocks collected mineral specimens for souvenirs. Total value reported was $55.

Lime.—Air Reduction Chemical & Carbide Co. calcined sludge to produce captive and open-market byproduct lime in plants in Marshall and Jefferson Counties.

Perlite.—Great Lakes Carbon Corp. of Kentucky expanded perlite, mined in Colorado, at the new Florence plant. The perlite was used in manufacturing insulation board.

Sand and Gravel.—Twenty-three producers, including the State and county highway departments, mined sand and gravel at 35 mines in 23 counties. Leading counties were Jefferson, Boone, and Trimble. Leading producers were Standard Materials Corp., Ohio River Sand Co., and Owensboro River Sand & Gravel Co. Inc. Production increased 6 percent over the 1962 record. Of the total production, 88 percent was washed. Fifty percent was hauled by truck, 46 percent by water, and 4 percent by rail.

Stone.—*Limestone.*—Eighty producers crushed limestone at 111 quarries in 66 counties. Leading counties were Livingston, Fayette, and Jefferson. Leading producers were Reed Crushed Stone Co. Inc. (Livingston County), Kentucky Stone Co. (Anderson, Breckinridge, Hardin, Jessamine, Lee, Logan, Rockcastle, and Todd Counties), and Lambert Bros. (Fayette and Jefferson Counties). Production increased 27 percent over the 1962 record. Of the total commercial tonnage, 90 percent was hauled by truck, 6 percent by rail, and 4 percent by water.

TABLE 6.—Sand and gravel sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Ballard	25,520	$12,860	23,649	$14,039
Calloway	27,242	70,311	40,906	41,954
Carlisle	8,621	4,331	6,155	3,102
Fulton	16,973	15,062	10,248	5,124
Graves			63,995	31,997
Hickman	17,946	8,973	9,868	5,034
Jefferson	2,276,294	1,957,360	2,293,206	1,913,663
Livingston	125,196	103,915	101,073	80,579
Lyon	752	376	2,522	1,261
Marshall	25,699	12,849	32,580	13,876
Martin			33,050	33,050
Mason	84,000	134,400	114,000	172,900
Oldham			(1)	(1)
Pike	4,750	4,702	3,750	3,450
Union	75,000	86,000	(1)	(1)
Undistributed [2]	3,449,365	2,967,165	3,744,771	3,751,251
Total	6,137,358	5,378,304	6,479,773	6,071,280

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes Boone, Breckinridge, Daviess, Gallatin, Henderson, Logan, McCracken, and Trimble Counties, and counties indicated by footnote 1.

TABLE 7.—Sand and gravel sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Paving	1,471,243	$1,207,746	$0.82	2,058,375	$1,870,009	$0.91
Structural	2,114,812	1,944,217	.92	2,010,764	1,908,542	.95
Fill	837,614	358,057	.43	494,296	232,195	.47
Molding				3,598	13,500	3.75
Glass	17,085	64,100	3.75			
Other	(1)	(1)	(1)	(1)	(1)	(1)
Gravel:						
Paving	1,027,380	939,019	.91	1,142,110	1,194,890	1.05
Structural	630,130	835,591	1.33	590,892	732,571	1.24
Fill	31,212	25,039	.80	167,265	111,094	.66
Other				(1)	(1)	(1)
Total sand and gravel [2]	6,137,358	5,378,304	.88	6,479,773	6,071,280	.94

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Total sand and gravel."
[2] Includes railroad ballast, engine, and other sands; and railroad ballast gravel.

Dimension limestone was quarried in Jessamine and Mercer Counties.

Sandstone.—Kentucky Flagstone Co. and U. F. Coleman quarried less than 1,000 tons of dimension sandstone in Logan and Christian Counties.

Vermiculite.—Zonolite Co. exfoliated vermiculite from other States and a foreign country at the Wilder plant near Newport.

METALS

Ferroalloys.—Shipments of ferroalloys, including ferromanganese, silicomanganese, silvery pig iron, ferrosilicon, ferrochromium, and ferrochromic silicon, increased 18 percent over those of 1962.

Lead.—Byproduct recovery of lead from fluorspar milling increased 12 percent.

Pig Iron and Steel.—Armco Steel Corp. produced foundry and basic pig iron at Ashland; production was 15 percent greater than in 1962. Steel was produced by Armco Steel Corp. at Ashland and by Acme Steel Co. at Newport. Iron ore consumed was 24 percent domestic imported and 76 percent.

Zinc.—By product recovery of zinc from fluorspar milling increased 25 percent but was 58 percent below the 1951 record.

TABLE 8.—Crushed limestone sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Barren	166,000	$242,400	417,000	$648,350
Bourbon	225,437	269,729	525,000	525,000
Boyle	272,261	420,372	251,331	384,959
Caldwell	(1)	(1)	1,345,000	1,582,600
Carter	493,495	635,546	566,924	733,884
Casey	104,412	159,708	122,000	209,000
Christian	(1)	(1)	1,132,140	1,590,340
Fayette	1,119,769	1,623,328	1,459,776	2,250,895
Franklin	635,239	811,895	800,146	936,184
Greenup	6,500	11,050	20,000	30,000
Hardin	756,288	1,004,511	1,184,181	1,530,375
Jefferson	1,382,821	2,050,675	1,425,661	2,165,394
Kenton	4,408	6,613	4,200	6,300
Menifee	89,124	143,777	(1)	(1)
Mercer	205,740	290,783	124,503	182,632
Montgomery			53,265	79,898
Morgan	254,564	355,401	(1)	(1)
Nicholas	40,300	75,900	45,000	65,000
Oldham	421,612	496,183	557,200	723,800
Powell	1,591,211	2,593,686	(1)	(1)
Simpson	112,318	170,870	(1)	(1)
Warren	497,373	701,581	(1)	(1)
Undistributed [2]	11,091,747	15,591,151	14,653,864	20,885,181
Total	19,470,619	27,655,159	24,687,191	34,529,792

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[2] Includes Adair, Allen, Anderson, Breckinridge, Butler, Clinton, Crittenden, Cumberland, Edmonson, Estill, Fleming, Garrard, Grayson, Green, Harlan, Harrison, Hart, Henry, Jackson, Jessamine, Laurel, Lee, Letcher, Livingston, Logan, Madison, Marion, Meade, Metcalfe, Monroe, Muhlenberg, Nelson, Ohio, Pendleton, Pike, Pulaski, Rockcastle, Rowan, Scott, Taylor, Todd, Trigg, Washington, and Wayne Counties, and counties indicated by footnote 1.

TABLE 9.—Crushed limestone sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	15,810,275	$22,762,772	$1.44	20,557,484	$29,231,263	$1.42
Agstone [1]	1,667,020	2,318,972	1.39	1,824,357	2,497,202	1.37
Railroad ballast	452,824	473,168	1.04	475,633	522,300	1.10
Stone sand	(2)	(2)	(2)	8,000	13,200	1.65
Other uses [3]	1,540,500	2,100,247	1.36	1,821,717	2,265,827	1.24
Total	19,470,619	27,655,159	1.42	24,687,191	34,529,792	1.40

[1] Agricultural stone.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[3] Includes riprap, fluxing stone, fertilizer filler, cement, other uses, and uses indicated by footnote 2.

REVIEW BY COUNTIES

Of the 120 counties, 108 reported mineral production, compared with 107 in 1962. Leading counties were the large coal and petroleum producers, Muhlenberg, Pike, Hopkins, Harlan, Letcher, Floyd, and Union, which supplied more than 50 percent of the total mineral production value. In addition to detailed county production listed in table 10, natural gas and natural gas liquids, of undetermined county origin, were produced. The number of wells and footage drilled by counties given in this section were published in the Oil and Gas Journal.[3]

Adair.—Shamrock Stone, Inc. (Butler quarry), crushed limestone for concrete, roads, and agricultural stone (agstone). A small quantity of crude petroleum was reported; one well totaling 70 feet was drilled.

Allen.—McLellan Stone Co. (Scottsville quarry) crushed limestone for railroad ballast, agstone, and other uses. Production of crude petroleum decreased 28 percent; 19 wells totaling 8,649 feet were drilled.

Anderson.—Kentucky Stone Co. (Tyrone mine) crushed limestone for concrete, roads, railroad ballast, and agstone.

Ballard.—The Kentucky State Highway Department mined paving sand and gravel.

Barren.—J. F. Pace Construction Co. crushed limestone for concrete, roads, agstone, and stone sand. Production of crude petroleum decreased 31 percent; 17 wells totaling 5,162 feet were drilled.

Bath.—Production of crude petroleum decreased 4 percent.

Bell.—Eighty-nine mines produced coal; the leading producers were Mill Creek Coal Co., Inc. (No. 2 mine), Roaring Fork Coal Co. (No. 3 mine), and Brownies Creek Collieries, Inc. (No. 1 mine). A small quantity of crude petroleum was reported.

[3] Oil and Gas Journal. V. 62, No. 4, Jan. 27, 1964, p. 171.

TABLE 10.—Value of mineral production in Kentucky, by counties [1]

County	1962	1963	Minerals produced in 1963 in order of value [2]
Adair	(3)	(3)	Limestone, petroleum.
Allen	(3)	(3)	Do.
Anderson	(3)	(3)	Limestone.
Ballard	$12,860	$14,039	Sand and gravel.
Barren	369,915	735,839	Limestone, petroleum.
Bath	15,792	14,959	Petroleum.
Bell	7,315,288	4,301,886	Coal, petroleum.
Boone	(3)	(3)	Sand and gravel.
Bourbon	269,729	525,000	Limestone.
Boyd	254,530	(3)	Coal, miscellaneous clay, petroleum.
Boyle	420,372	384,959	Limestone.
Breathitt	3,842,619	1,518,527	Coal, petroleum.
Breckinridge	(3)	(3)	Limestone, petroleum, sand and gravel.
Bullitt	(3)	(3)	Miscellaneous clay.
Butler	(3)	(3)	Coal, petroleum, limestone.
Caldwell	(3)	(3)	Limestone, fluorspar.
Calloway	70,311	41,954	Sand and gravel.
Carlisle	4,331	3,102	Do.
Carter	1,182,536	1,458,347	Limestone, fire clay, coal.
Casey	260,750	253,521	Limestone, petroleum.
Christian	(3)	(3)	Petroleum, limestone, coal, miscellaneous clay, sandstone.
Clay	4,077,350	4,981,929	Coal.
Clinton	(3)	(3)	Petroleum, limestone, coal.
Crittenden	(3)	(3)	Limestone, fluorspar, barite, petroleum.
Cumberland	(3)	(3)	Petroleum, limestone.
Daviess	(3)	(3)	Petroleum, coal, sand and gravel.
Edmonson	(3)	(3)	Limestone, petroleum.
Elliott	244,272	202,367	Petroleum, coal.
Estill	(3)	(3)	Petroleum, limestone.
Fayette	1,623,328	2,250,895	Limestone.
Fleming	(3)	(3)	Do.
Floyd	20,574,311	24,102,588	Coal, petroleum.
Franklin	811,895	936,184	Limestone.
Fulton	15,062	5,124	Sand and gravel.
Gallatin	(3)	(3)	Do.
Garrard	(3)	(3)	Limestone.
Graves	(3)	(3)	Ball clay, sand and gravel.
Grayson	(3)	(3)	Limestone.
Green	(3)	(3)	Petroleum, limestone.
Greenup	419,006	228,096	Fire clay, limestone, coal.
Hancock	(3)	(3)	Petroleum, miscellaneous clay, coal, fire clay.
Hardin	1,012,361	1,535,248	Limestone, petroleum.
Harlan	(3)	(3)	Coal, limestone.
Harrison	(3)	(3)	Limestone.
Hart	(3)	(3)	Limestone, petroleum.
Henderson	(3)	(3)	Petroleum, coal, sand and gravel.
Henry	(3)	(3)	Limestone, gem stones.
Hickman	8,973	5,034	Sand and gravel.
Hopkins	(3)	42,373,365	Coal, petroleum.
Jackson	(3)	(3)	Limestone, coal, petroleum.
Jefferson	(3)	(3)	Cement, limestone, sand and gravel, miscellaneous clay.
Jessamine	(3)	(3)	Limestone.
Johnson	1,147,332	1,628,208	Petroleum, coal.
Kenton	6,613	6,300	Limestone.
Knott	6,276,739	6,844,158	Coal, petroleum.
Knox	939,840	1,304,941	Do.
Laurel	(3)	(3)	Coal, limestone, petroleum.
Lawrence	1,273,323	1,592,316	Petroleum, coal.
Lee	(3)	(3)	Petroleum, limestone, coal.
Leslie	6,943,484	9,265,654	Coal, petroleum.
Letcher	(3)	(3)	Coal, limestone, petroleum.
Lincoln	23,061	7,431	Petroleum.
Livingston	(3)	(3)	Limestone, fluorspar, zinc, lead, sand and gravel, silver, gem stones.
Logan	(3)	(3)	Limestone, sandstone, sand and gravel, petroleum.
Lyon	376	1,261	Sand and gravel.
Madison	(3)	(3)	Limestone.
Magoffin	3,146,507	3,161,654	Petroleum, coal.
Marion	(3)	(3)	Limestone.
Marshall	12,849	13,876	Sand and gravel.
Martin	371,382	694,617	Coal, petroleum, sand and gravel.
Mason	134,400	172,900	Sand and gravel.
McCracken	(3)	(3)	Do.
McCreary	1,324,802	1,271,325	Coal, petroleum.
McLean	2,676,848	2,546,099	Petroleum, coal.

See footnotes at end of table.

TABLE 10.—Value of mineral production in Kentucky, by counties [1]—Continued

County	1962	1963	Minerals produced in 1963 in order of value [2]
Meade	(3)	(3)	Limestone.
Menifee	$145,302	(3)	Limestone, petroleum.
Mercer	290,783	(3)	Limestone.
Metcalfe	(3)	(3)	Petroleum, limestone.
Monroe	(3)	(3)	Limestone, petroleum.
Montgomery	----------	$79,898	Limestone.
Morgan	516,021	(3)	Limestone, coal, petroleum.
Muhlenberg	(3)	(3)	Coal, petroleum, limestone.
Nelson	(3)	(3)	Limestone.
Nicholas	75,900	65,000	Do.
Ohio	(3)	(3)	Coal, petroleum, limestone.
Oldham	496,183	(3)	Limestone, sand and gravel.
Owsley	14,448	20,818	Coal, petroleum.
Pendleton	(3)	(3)	Limestone.
Perry	14,544,922	14,395,484	Petroleum, coal.
Pike	(3)	(3)	Coal, petroleum, limestone, sand and gravel.
Powell	(3)	(3)	Limestone, petroleum, miscellaneous clay.
Pulaski	(3)	(3)	Limestone, coal.
Rockcastle	(3)	(3)	Do.
Rowan	669,840	897,524	Fire clay, limestone, miscellaneous clay.
Russell	16,010	13,131	Petroleum.
Scott	(3)	(3)	Limestone.
Simpson	203,563	(3)	Limestone, petroleum.
Taylor	(3)	(3)	Do.
Todd	(3)	(3)	Do.
Trigg	(3)	(3)	Limestone.
Trimble	(3)	(3)	Sand and gravel.
Union	14,774,999	(3)	Coal, petroleum, sand and gravel, miscellaneous clay.
Warren	833,584	(3)	Limestone, petroleum.
Washington	(3)	(3)	Limestone.
Wayne	(3)	(3)	Limestone, petroleum, coal.
Webster	5,428,312	5,182,492	Petroleum, coal.
Whitley	(3)	(3)	Coal, petroleum, miscellaneous clay.
Wolfe	126,079	119,402	Petroleum, coal.
Undistributed [4]	[5] 293,316,907	299,588,548	
Total	[5] 398,536,000	434,746,000	

[1] Excludes natural gas and natural gas liquids; included with "Undistributed." The following counties did not report production: Bracken, Campbell, Carroll, Clark, Grant, Larue, Lewis, Owen, Robertson, Shelby, Spencer, and Woodford.
[2] Other than natural gas and natural gas liquids.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Includes natural gas, natural gas liquids, and values indicated by footnote 3.
[5] Revised figure.

Boone.—Standard Materials Corp. (Belleview mine), R. W. Greene, Jr. Sand & Gravel Co., Inc. (Burlington mine), and Kentucky Sand Co. (Taylorsport mine) mined sand and gravel for structural, paving, and fill uses. Great Lakes Carbon Corp. of Kentucky reported production of expanded perlite at the Florence plant for use in manufacturing insulation board.

Bourbon.—Bourbon Limestone Co., Inc. (Snapp quarry), crushed limestone for concrete, roads, and agstone.

Boyd.—Rush Coal Corp. (No. 1 Strip mine), Big Run Coal & Clay Co. (Big Run mine), and Ferguson & Yates Coal Co. (No. 1 mine) mined bituminous coal. Big Run Coal & Clay Co. (Princess mine) mined miscellaneous clay for use in heavy clay products. Production of crude petroleum decreased 47 percent; 3 wells totaling 9,027 feet were drilled. Armco Steel Corp. produced pig iron and steel at the Ashland plant. Allied Chemical Corp. produced metallurgical coke at its Ashland plant.

Boyle.—Caldwell Stone Co., Inc. (Danville quarry), and Boyle County Highway Department (Perryville quarry) crushed limestone for concrete, roads, and agstone.

Breathitt.—Sixteen mines produced coal; the leading producers were Island Creek Coal Co. (No. 3 Elkhorn mine), Kentucky River Collieries (No. 1 strip mine), and White Oak Coal Co. (No. 1 strip mine). Production of crude petroleum decreased 29 percent; 6 wells totaling 5,334 feet were drilled.

Breckinridge.—Kentucky Stone Co. (Webster quarry) and White Stone Co. (Hardinsburg quarry) crushed limestone for concrete, roads, railroad ballast, and agstone. Cloverport Sand & Gravel Co. mined structural and paving sand and gravel. Production of crude petroleum decreased 37 percent; 19 wells totaling 8,325 feet were drilled.

Bullitt.—Kenlite Division of Kentucky Light Aggregates, Inc. (Shepherdsville mine), mined miscellaneous clay for lightweight aggregates.

Butler.—Five mines produced coal; the leading producers were Williams Bros. Stripping Corp. (South Hill strip mine), and John Farris Coal Co. (Farris strip mine). Production of crude petroleum decreased 34 percent; 39 wells totaling 23,217 feet were drilled. Gary Bros. Crushed Stone Co. (Morgantown quarry) crushed limestone for concrete, roads, and agstone.

Caldwell.—Cedar Bluff Stone Co., Inc., Tom Hamilton and Greenville Quarries, Inc. (Cedar Bluff No. 2 quarry), and Fredonia Valley Quarries, Inc. (Fredonia quarry), crushed limestone for concrete, roads, and agstone. James Green mined a small quantity of fluorspar. Five oil wells totaling 6,862 feet were drilled.

Calloway.—Murray Silica Sand Co. mined silica sand for use as a molding sand. The State highway department and Calloway County Highway Department mined paving gravel.

Campbell.—Zonolite Co. exfoliated crude vermiculite shipped into the State at the Wilder plant.

Carlisle.—The State highway department mined paving sand and gravel.

Carter.—Acme Stone Co., Inc., Carter County Stone Co., and Standard Slag Co. crushed limestone for concrete, roads, and agstone. Thirteen mines produced fire clay for firebrick and block and fire clay mortar; the leading producers were Davis Fire Brick Co. (Gannon, Messer-Kiser, and Ramey mines), General Refractories Co. (Little Hill, Parsons Strip, G. Lowe, and Crum No. 1 mines), and Hensley Mining Co. (Bailey mine). Five mines produced coal; the leading producers were Elliott County Mining Co. (No. 4 mine) and Lost Creek Coal Co. (Nos. 1 and 4 mines). One oil well totaling 3,594 feet was drilled.

Casey.—Casey Stone Co. (Bethel Ridge mine) crushed limestone for concrete, roads, and agstone. Production of crude petroleum decreased 56 percent; one well totaling 2,003 feet was drilled.

Christian.—Hopkinsville Stone Co., Inc., Harry Berry, Inc. (Fort Campbell quarry), and Christian Quarries, Inc., quarried limestone for riprap, concrete, roads, railroad ballast, and agstone. V. F. Coleman (Cerulean quarry) quarried dimension sandstone for rough building stone. Dalton Bros. Brick Co. mined miscellaneous clay for use in heavy clay products. Ralph Ligon, Inc. (No. 6 strip mine), was the only coal producer. Production of crude petroleum decreased 37 percent; 16 wells totaling 12,498 feet were drilled.

Clark.—Five oil wells totaling 8,310 feet were drilled.

Clay.—Sixty mines produced coal; the leading producer was Finley Coal Co. (Nos. 5, 6, and 7 mines). One oil well totaling 1,531 feet was drilled.

Clinton.—Shamrock Stone, Inc. (Caldwell quarry), crushed limestone for concrete, roads, and agstone. O. D. Gwinn Coal Co. (Gwinn mine) and B&S Coal Co. (No. 1 mine) mined bituminous coal. Production of crude petroleum decreased 31 percent; nine wells totaling 9,947 feet were drilled.

Crittenden.—Alexander Stone Co., Inc., quarried limestone for riprap, concrete, roads, and agstone. C&L Fluorspar Co., Mafluor Corp. (Pigmy mine), and Craighead & Coates (Stallions mine) mined metallurgical-grade fluorspar. Kentucky Fluorspar Co. and Roberts & Frazier purchased fluorspar for shipment to consumers. Calvert City Chemical Co. treated fluorspar ore from its Dyer's Hill mine in Livingston County, in its flotation mill at Mexico, recovering fluorspar for use in manufacturing hydrofluoric acid. Mafluor Corp. (Pigmy mine) mined barite for use in oil well drilling. Production of crude petroleum increased 5 percent; four wells totaling 4,857 feet were drilled.

Cumberland.—Shamrock Stone, Inc. (Wells quarry), crushed limestone for concrete, roads, and agstone. Production of crude petroleum decreased 10 percent; 10 wells totaling 7,291 feet were drilled.

Daviess.—Owensboro River Sand & Gravel Co. and Daviess County Sand & Gravel Co. mined sand and gravel for structural, paving, fill, and engine uses. Five mines produced coal; the leading producers were Green Coal Co. (K–9 strip mine) and Daviess County Coal Co. (Daviess No. 2 mine). Production of crude petroleum decreased 6 percent; 231 wells totaling 328,748 feet were drilled.

Edmonson.—McLellan Stone Co. (Park City quarry) and Nolin Stone Co., Inc. (Bee Spring quarry), crushed limestone for concrete, roads, and agstone. Production of crude petroleum increased 26 percent; one well totaling 1,187 feet was drilled.

Elliott.—Copley Coal Co. (No. 5 mine), Roprest Coal Co. (No. 1 mine), and Jeff Branch Coal Co. (No. 1–A mine) mined bituminous coal. Production of crude petroleum decreased 22 percent; two wells totaling 1,682 feet were drilled.

Estill.—Estill County Stone Co., Inc., quarried limestone for riprap, concrete, roads, and agstone. Production of crude petroleum decreased 3 percent; 6 wells totaling 2,989 feet were drilled.

Fayette.—Lambert Bros., Central Rock Co., Inc. (Lexington quarry and Lexington mine), and Blue Grass Stone Co., Inc., crushed limestone for concrete, roads, and agstone.

Fleming.—Gorman Construction Co., Inc. (Carpenter quarry), crushed limestone for concrete, roads, and agstone.

Floyd.—Floyd County ranked sixth in the State in total value of mineral production. One hundred and ninety-nine mines produced coal; the leading producers were Inland Steel Co. (Wheelwright mine) and Princess Coals, Inc. (Permele No. 2 and Open Fork mines). Production of crude petroleum increased 13 percent; 23 wells totaling 48,996 feet were drilled.

Franklin.—Franklin County Stone Co., Blanton Stone Co., Inc. (Frankfort mine), and Frankfort Builders Supply Co., Inc. (Devil's Hollow mine), quarried limestone for riprap, concrete, roads, and agstone.

Fulton.—The State highway department mined paving gravel.

Gallatin.—Standard Materials Corp. (Warsaw mine) and C&H Gravel Co., Inc. (Sam Hill mine), mined sand and gravel for structural and paving uses.

Garrard.—Camp Nelson Stone Co., Inc. (Lancaster quarry), crushed limestone for concrete and roads.

Graves.—Kentucky-Tennessee Clay Co. and Old Hickory Clay Co. (Hickory and Lampkin mines) mined ball clay for whiteware, art pottery, enameling, floor and wall tile, firebrick and block, foundries and steelworks, plastics, exports, and other uses. The State highway department mined paving gravel.

Grayson.—Ragland Quarry, Inc. (Ragland No. 2 and Leitchfield quarries), and Rogers & Brunnhoeffer (Grayson quarry) crushed limestone for concrete, roads, and agstone. Two oil wells totaling 1,307 feet were drilled.

Green.—Nally & Gibson Stone Co. (Greensburg quarry) crushed limestone for concrete and roads. Production of crude petroleum decreased 37 percent; 14 wells totaling 6,327 feet were drilled.

Greenup.—Six mines produced fire clay for firebrick and block, fire clay mortar, heavy clay products, and other clay specialties. The leading producers were M. A. McCoy & Sons Clay Co. (Morris Smith and Large mines) and Harbison-Walker Refractories Co. (Riggs mine). Spencer Sweeney Coal Co. (No. 1 mine) mined bituminous coal. Greenup County Highway Department crushed limestone for concrete and roads.

Hancock.—Four mines produced miscellaneous clay for heavy clay products; the leading producer was Cannelton Sewer Pipe Co. (No. 1 mine). American Olean Tile Co. mined fire clay for floor and wall tile use. Watken Construction Co. (Carbon No. 2 strip mine) and R&W Coal Co. (No. 1 strip mine) mined bituminous coal. Production of crude petroleum decreased 16 percent; 8 wells totaling 9,493 feet were drilled.

Hardin.—Four quarries and one mine produced limestone for riprap, concrete, roads, agstone, and fertilizer filler. The leading producers were Kentucky Stone Co. (Lilmay mine and Upton quarry) and Rogers & Bunnhoeffer (Stephensburg quarry). Production of crude petroleum decreased 37 percent; one well totaling 850 feet was drilled.

Harlan.—Harlan County ranked fourth in the State in value of mineral production. One hundred and fifty-four mines produced coal; the leading producers were United States Steel Co. (No. 32 mine), Shackleford Coal Co., Inc. (Glenbrook High Splint mine), and International Harvester Co. (No. 4 mine). Nally & Boone Stone Co. (Harlan quarry) crushed limestone for concrete, roads, and agstone.

Harrison.—Genet Stone Co., Inc. (Cynthiana quarry), crushed limestone for concrete, roads, and agstone.

Hart.—McLellan Stone Co. (Horse Cave quarry), crushed limestone, for concrete, roads, and agstone. Production of crude petroleum decreased 9 percent; 4 wells totaling 3,631 feet were drilled.

Henderson.—Evansville Materials, Inc., dredged sand and gravel for structural, paving, railroad ballast, and fill uses. Seven mines produced coal; the leading producers were Goldsberry Coal Co. (No. 2 mine) and Dolph Hazelwood Coal Co. (Mike & Pat and No. 3 mines). Production of crude petroleum increased 21 percent; 103 wells totaling 174,309 feet were drilled.

Henry.—Geoghegan & Mathis, Inc. (Lockport quarry), crushed limestone for concrete, roads, and agstone. Major Rocks collected a small quantity of gem stones (agate and flint).

Hickman.—The State highway department mined sand and gravel for paving uses.

Hopkins.—Hopkins County ranked third in the State in total value of mineral production. Thirty-four mines produced coal; the leading producers were West Kentucky Coal Co. (East Diamond and Pleasant View mines) and Nashville Coal Inc. (Fies mine). Crude petroleum production increased substantially over that reported in 1962; 271 wells totaling 704,018 feet were drilled.

Jackson.—M. A. Walker Co., Inc. (Indian Creek and Clover Bottom mines), crushed limestone for concrete, roads, and agstone. Six mines produced coal; the leading producer was Hamm Coal Co., Inc. (No. 1 auger and No. 2 strip mines). Production of crude petroleum decreased 25 percent.

Jefferson.—Kosmos Portland Cement Co. produced masonry and portland cements at the Kosmosdale plant. Limestone was crushed at four quarries and one mine for concrete, roads, and agstone. The major producers were Lambert Bros. (Okolona quarry) and Louisville Crushed Stone Co. (Louisville mine). Five mines produced sand and gravel for structural, paving, fill, and other uses. The leading producers were Ohio River Sand Co., Inc., and Nugent Sand Co. Kosmos Portland Cement Co. (Kosmosdale mine) and General Shale Products Co. (Coral Ridge mine) mined miscellaneous clay for use in cement manufacture and heavy clay products. Air Reduction Chemical & Carbide Co. regenerated lime for chemical and industrial uses at the Louisville plant.

Jessamine.—Kentucky Stone Co. (High Bridge mine) crushed limestone for concrete, roads, railroad ballast, and agstone. Isom Hall Garage quarried dimension limestone for rough building stone.

Johnson.—Forty-eight mines produced coal; the leading producers were Tutor Key Coal Co. (No. 1 mine), Stambaugh Coal Co. (No. 3 mine), and Bob Cantrell Coal Co. (No. 7 mine). Production of crude petroleum increased 54 percent; 107 wells totaling 95,205 feet were drilled.

Kenton.—Franxman Bros. crushed limestone for concrete and roads.

Knott.—One hundred and fifty-one mines produced coal; the leading producers were Flame Coal Co. (No. 1 strip mine), Mountain Top Stripping Co., Inc. (No. 1 strip mine), and Combs Fork Coal Co. (No. 1 mine). Production of crude petroleum decreased 11 percent.

Knox.—Kentucky-Knox Mining Co., Inc. (No. 1 strip and No. 3 auger mines) and Gold Star Coal Co. (No. 1 strip mine) were the

principal producers among the 64 active coal mines. Production of crude petroleum decreased 5 percent; 19 wells totaling 48,315 feet were drilled.

Laurel.—Kentucky Stone Co. (Laurel quarry) crushed limestone for concrete and roads. Eight mines produced coal; the leading producers were Hap Coal Co. (No. 1 mine) and Laurel County Coal Co., Inc. (No. 1 strip mine). There was a substantial decrease in production of crude petroleum; two wells totaling 7,132 feet were drilled.

Lawrence.—F&F Mining Corp. (No. 1 strip mine), C&C Coal Co. (Van Horn No. 1 mine), and Kazee Coal Co. (No. 1 mine) mined bituminous coal. Production of crude petroleum increased 23 percent; 23 wells totaling 42,473 feet were drilled.

Lee.—Kentucky Stone Co. (Yellow Rock mine) crushed limestone for concrete, roads, railroad ballast, and agstone. Five mines produced coal; the leading producers were S&F Coal Co. (S&F No. 1 mine) and Congleton Bros. Coal Co., Inc. (No. 5 Pacemaker mine). Production of crude petroleum increased 11 percent; 94 wells totaling 80,120 feet were drilled.

Leslie.—Forty-one mines produced coal; the leading producers were Deby Coal Co. (Deby No. 2 mine), Delta Mining Co. (No. 1 auger mine), and Smith Coal Sales, Inc. (No. 1 mine). Production of crude petroleum decreased 27 percent.

Letcher.—Letcher County ranked fifth in the State in total value of mineral production. Two hundred and forty-four mines produced coal; the leading producers were Bethlehem Mines Corp. (Nos. 20, 21, and 22 mines) and South East Coal Co. (Big Chief and Polly No. 4 mines). Levisa Stone Corp. (Jenkins quarry) and Hurricane Gap Quarries, Inc., crushed limestone for concrete and roads. Production of crude petroleum decreased 11 percent; 4 wells totaling 14,590 feet were drilled.

Lewis.—Two oil wells totaling 770 feet were drilled.

Lincoln.—There was a substantial decrease (68 percent) in production of crude petroleum. Two wells totaling 413 feet were drilled.

Livingston.—Reed Crushed Stone Co., Inc. (Grand Rivers quarry), and Three River Rock Co. (Smithland quarry) quarried limestone for riprap, concrete, roads, and agstone. Calvert City Chemical Co. mined fluorspar ore at the Dyer's Hill mine and treated it in the Mexico mill in Crittenden County to recover acid-grade fluorspar. Nancy Hanks Mines, Inc., reopened the Nancy Hanks mine and mined a small quantity of fluorspar. Byproduct zinc, lead, and silver were recovered from fluorspar milling. Taylor Sand & Gravel Co. (Barkley Dam mine) and the State highway department mined structural sand and paving gravel. Major Rocks collected a small quantity of gem stones (fluorite and sphalerite).

Logan.—Kentucky Stone Co. (Russellville mine) crushed limestone for concrete, roads, railroad ballast, and agstone. Kentucky Flagstone Co., Inc. (Lewisburg quarry), quarried dimension sandstone for rough architectural stone and flagging. Kemp Construction Co. mined sand and gravel for structural and paving uses. Production of crude petroleum increased 57 percent; 13 wells totaling 8,412 feet were drilled.

Lyon.—The State highway department mined paving gravel.

Madison.—Boonesboro Quarry, Inc. (Boonesboro mine), crushed limestone for concrete, roads, and agstone.

Magoffin.—Ten mines produced coal; the leading producer was Tip Top Coal Co. (Nos. 23, 24, and 26 mines). Production of crude petroleum decreased 5 percent; 44 wells totaling 50,455 feet were drilled.

Marion.—Ward & Montgomery (Lebanon quarry) and Lebanon Stone Co., Inc., crushed limestone for concrete, roads, and agstone.

Marshall.—The State highway department mined paving gravel. Air Reduction Chemical & Carbide Co. regenerated lime for chemical and industrial uses at the Calvert City plant. Pittsburgh Metallurgical Co. produced ferroalloys at the Calvert City plant. New York Mining & Manufacturing Co. produced metallurgical coke.

Martin.—Wolf Creek Coal Co. (No. 1 mine), Spence & Fannin Coal Co. (No. 2 mine), and Jean Coal Co. (No. 7 mine) mined bituminous coal. Sands of Rockcastle Creek, Inc. (Rockcastle mine), mined structural and paving sand. Production of crude petroleum decreased 13 percent; 5 wells totaling 11,041 feet were drilled.

Mason.—J. F. Hardyman Co. mined sand and gravel for structural, paving, and fill uses.

McCracken.—Federal Materials Co., Inc., and McCracken County Highway Department mined sand and gravel for structural, paving, and fill uses. One oil well totaling 1,200 feet was drilled.

McCreary.—Nine mines produced coal; the leading producer was Stearns Coal & Lumber Co. (Nos. 16–2 and 19 mines). Production of crude petroleum decreased 46 percent; 5 wells totaling 5,159 feet were drilled.

McLean.—Highview Coal & Construction Co. (Island No. 2 strip mine) and Fox Hollow Coal Co. (Fox Hollow mine) were the active coal producers. Production of crude petroleum decreased 3 percent; 71 wells totaling 108,518 feet were drilled.

Meade.—Kosmos Portland Cement Co., Owensboro River Sand & Gravel Co., Inc. (Riverside mine), and Doe Run Stone Co. crushed limestone for concrete, roads, agstone, and cement manufacture.

Menifee.—A. W. Walker & Son (Indian Creek quarry) crushed limestone for concrete, roads, and agstone. Production of crude petroleum increased 33 percent; 5 wells totaling 4,159 feet were drilled.

Mercer.—Mercer Stone Co. and Mercer County Highway Department crushed limestone for concrete, roads, and agstone. Kentucky Marble Quarry, Inc., quarried dimension limestone for dressed building stone, curbing, and flagging.

Metcalfe.—Montgomery & Co. (Chapman quarry) crushed limestone for concrete, roads, and agstone. Production of crude petroleum increased 42 percent; 115 wells totaling 40,715 feet were drilled.

Monroe.—Trico Stone, Inc. (Monroe quarry), crushed limestone for concrete, roads, and agstone. Production of crude petroleum substantially increased.

Montgomery.—Montgomery County Stone Co. (Mount Sterling quarry) crushed limestone for concrete, roads, and agstone.

Morgan.—Licking River Limestone Co. (Zag quarry), Kentucky Road Oiling Co. (Wrigley quarry), and Morgan County Limestone, Inc. (Sandy Hook quarry), produced limestone for riprap, concrete, roads, and agstone. Marshall, Branham & Sheets Coal Co. (No. 3

strip mine), B&B Coal Co. (No. 1 mine), and Daniel Coal Co. (No. 1 strip mine) mined bituminous coal. Production of crude petroleum increased 27 percent; 3 wells totaling 4,523 feet were drilled.

Muhlenberg.—Muhlenberg County ranked first in the State in total value of mineral production. Sixteen mines produced coal; the leading producers were River Queen Coal Co. (River Queen strip mine), Peabody Coal Co. (Sinclair strip mine), and Gibralter Coal Corp. (Gibralter strip mine). Greenville Quarries, Inc., and AAA Stone Co., Inc., crushed limestone for concrete, roads, and agstone. Crude petroleum production decreased 25 percent; 100 wells totaling 128,601 feet were drilled.

Nelson.—Geoghegan & Mathis, Inc. (Nelson quarry), crushed limestone for concrete, roads, and agstone.

Nicholas.—Nicholas County Highway Department crushed limestone for concrete, roads, and agstone.

Ohio.—Seventeen mines produced coal; the leading producers were Peabody Coal Co. (Ken strip and Ken Highwall No. 2 mines) and Riverview Coal Co., Inc. (No. 1 strip mine). Fort Hartford Stone Co., Inc. (Hartford mine) and State Contracting & Stone (Hartford quarry) produced limestone for riprap, concrete, roads, railroad ballast, and agstone. Production of crude petroleum decreased 1 percent; 150 wells totaling 103,993 feet were drilled.

Oldham.—Ohio River Stone Co. (Prospect mine), Joe Clark Stone Co., and Liter's Quarry, Inc. (Crestwood mine), crushed limestone for concrete, roads, and agstone. Standard Materials Corp. (Harmony Landing mine) mined gravel for fill uses.

Owsley.—Booneville Fuel Co. (No. 1 mine) mined bituminous coal. Production of crude petroleum decreased 26 percent.

Pendleton.—Geoghegan & Mathis, Inc. (Butler and Falmouth quarries), crushed limestone for concrete, roads, and agstone.

Perry.—Eighty-seven mines produced coal; the leading producers were Blue Diamond Coal Co. (Leatherwood No. 1 mine), Blair Fork Coal Co. (Blair Fork mine), and Black Diamond Coal Co. (No. 1 auger mine). Production of crude petroleum decreased 34 percent; 34 wells totaling 101,477 feet were drilled.

Pike.—Pike County ranked second in the State in total value of mineral production. Six hundred and nine mines produced coal; the leading producers were Eastern Coal Corp. (Stone mine), Kentland-Elkhorn Coal Corp. (Kentland No. 1 mine), and Republic Steel Corp. (Republic mine). Johnson Bros. Limestone Co. crushed limestone for concrete and roads. Pike Sand Co. (Walters mine) mined structural sand. Crude petroleum production decreased 12 percent; 23 wells totaling 57,513 feet were drilled.

Powell.—A. W. Walker & Son (No. 213 quarry) and Natural Bridge Stone, Inc. (Stanton quarry), crushed limestone for concrete, roads, and agstone. Big Run Coal & Clay Co. (West Bend mine) and H. B. Sipple Brick Co. (Drake No. 1 mine) mined miscellaneous clay for use in heavy clay products. Production of crude petroleum decreased 20 percent; 19 wells totaling 17,066 feet were drilled.

Pulaski.—Strunk Construction Co., Inc. (Tateville quarry), and Somerset Stone Co., Inc. (Somerset quarry), crushed limestone for concrete, roads, and agstone. Seven mines produced coal; the leading

producer was Ikerd & Bandy. Three oil wells totaling 927 feet were drilled.

Rockcastle.—Kentucky Stone Co. (Mt. Vernon and Mullins mines) crushed limestone for concrete, roads, railroad ballast, and agstone. R&M Coal Co. (No. 1 mine), General Robinson Coal Co. (No. 1 strip mine), and Long Branch Coal Co. (No. 1 mine) mined bituminous coal. Two oil wells totaling 598 feet were drilled.

Rowan.—Morehead Limestone, Inc., and Kentucky Road Oiling Co. (Christy quarry) produced limestone for fluxing stone, concrete, roads, and agstone. Seven mines produced fire clay for fire brick and block use; the leading producer was Cogswell-Fultz strip mine (General Refractories Co.). Lee Clay Products Co., Inc., mined miscellaneous clay for use in heavy clay products. One oil well totaling 2,855 feet was drilled.

Russell.—Production of crude petroleum decreased 17 percent.

Scott.—Nally & Gibson Stone Co. (Georgetown quarry) crushed limestone for concrete and roads.

Simpson.—Southern Stone Co., Inc. (Franklin quarry), crushed limestone for concrete, roads, and agstone. Production of crude petroleum decreased 31 percent.

Taylor.—Nally & Gibson Stone Co. (Campbellsville quarry) crushed limestone for concrete and roads. Crude petroleum production decreased 93 percent.

Todd.—Kentucky Stone Co. (Todd quarry) and D. W. Dickinson & Son (Gallatin quarry) crushed limestone for concrete, roads, and agstone. Crude petroleum production decreased 39 percent.

Trigg.—Cedar Bluff Stone Co., Inc. (Canton quarry), crushed limestone for concrete, roads, and agstone. One oil well totaling 1,252 feet was drilled.

Trimble.—Standard Materials Corp. (Milton mine) mined sand and gravel for structural, paving, and fill uses.

Union.—Union County ranked seventh in the State in total value of mineral production. Five mines produced coal; the leading producers were Nashville Coal Inc. (Uniontown mine), P&M Coal Mining Co. (Dekoven mine), and Black Tom Mining Co. (Black Tom No. 1 strip mine). Production of crude petroleum increased 10 percent; 25 wells totaling 54,397 feet were drilled. Union Sand & Gravel Co. (Morganfield mine) mined sand and gravel for structural, paving, and fill uses. Clarks Clay Products Co. mined miscellaneous clay for use in heavy clay products.

Warren.—Gary Bros. Crushed Stone Co. and McLellan Stone Co. (Warren and Smith Grove quarries) crushed limestone for concrete, roads, agstone, and other uses. Production of crude petroleum decreased 4 percent; two wells totaling 1,303 feet were drilled.

Washington.—Nally & Gibson Stone Co. (Washington quarry) crushed limestone for concrete and roads.

Wayne.—Bassett Products Co. (Bassett quarry) crushed limestone for concrete, roads, and agstone. Reynolds Coal Co. (No. 1 mine) was the only active coal producer. Production of crude petroleum decreased 26 percent; 24 wells totaling 12,243 feet were drilled.

Webster.—Production of crude petroleum increased 13 percent; 68 wells totaling 134,841 feet were drilled. Five mines produced coal;

the leading producers were Sextet Mining Corp. (Choctaw strip mine) and Quisenberry Bros. Mining Co. (Quisenberry strip mine).

Whitley.—Forty-seven mines produced coal. The leading producers were Round Mountain Coal Co., Inc. (No. 1 strip and No. 1 auger mines), and Twin Peaks Coal Co. (No. 3 mine). Production of crude petroleum decreased 10 percent; eight wells totaling 8,812 feet were drilled. Corbin Brick Co., Inc. mined miscellaneous clay for use in heavy clay products.

Wolfe.—C. L. Thompson Coal Co. (Miller mine) and Herman Nickell Coal Co. (No. 1 mine) mined bituminous coal. Production of crude petroleum decreased 17 percent; 11 wells totaling 14,917 feet were drilled.

The Mineral Industry of Louisiana

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Louisiana Geological Survey for collecting information on all minerals except fuels.

By Peter Grandone,[1] Owen W. Jones,[2] and Leo W. Hough [3]

LOUISIANA ranked second in the Nation in value of mineral production for the 6th consecutive year. To keep abreast of accelerated industrial development in the State, new records were achieved in production of crude petroleum, natural gas, natural gas liquids and salt.

The mineral industry was dominated by hydrocarbon fuels—crude petroleum, natural gas, and natural gas liquids—which furnished 95 percent of the total value of mineral output. Proved recoverable reserves of the fuels reached new highs despite increased production. In quantity of reserves added during 1963, Louisiana ranked first in the Nation for natural gas, second for natural gas liquids, and sixth for crude petroleum. Nationally, recoverable reserves showed gains for natural gas and natural gas liquids and a loss for petroleum.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real

TABLE 1.—Mineral production in Louisiana [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	638	$641	655	$655
Lime—do	624	6,519	657	6,862
Natural gas—million cubic feet	3,525,456	694,515	3,928,427	777,829
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	1,010,137	74,726	1,143,707	81,332
LP gases—do	862,772	29,037	1,113,670	41,043
Petroleum (crude)—thousand 42-gallon barrels	477,153	1,502,568	[2] 522,739	[3] 1,631,792
Salt—thousand short tons	5,248	27,407	6,199	30,450
Sand and gravel—do	12,040	14,817	12,500	14,701
Stone (shell)—do	5,711	8,067	5,408	7,961
Sulfur (Frasch process)—thousand long tons	2,262	49,772	2,445	48,905
Value of items that cannot be disclosed: Cement, gypsum, and miscellaneous stone		18,554		20,531
Total		[3] 2,426,623		2,662,061

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Preliminary figure.
[3] Revised figure.

[1] Supervising petroleum and natural gas engineer, Bureau of Mines, Bartlesville, Okla.
[2] Petroleum and natural gas engineer, Bureau of Mines, Bartlesville, Okla.
[3] State geologist, Louisiana Geological Survey, Baton Rouge, La.

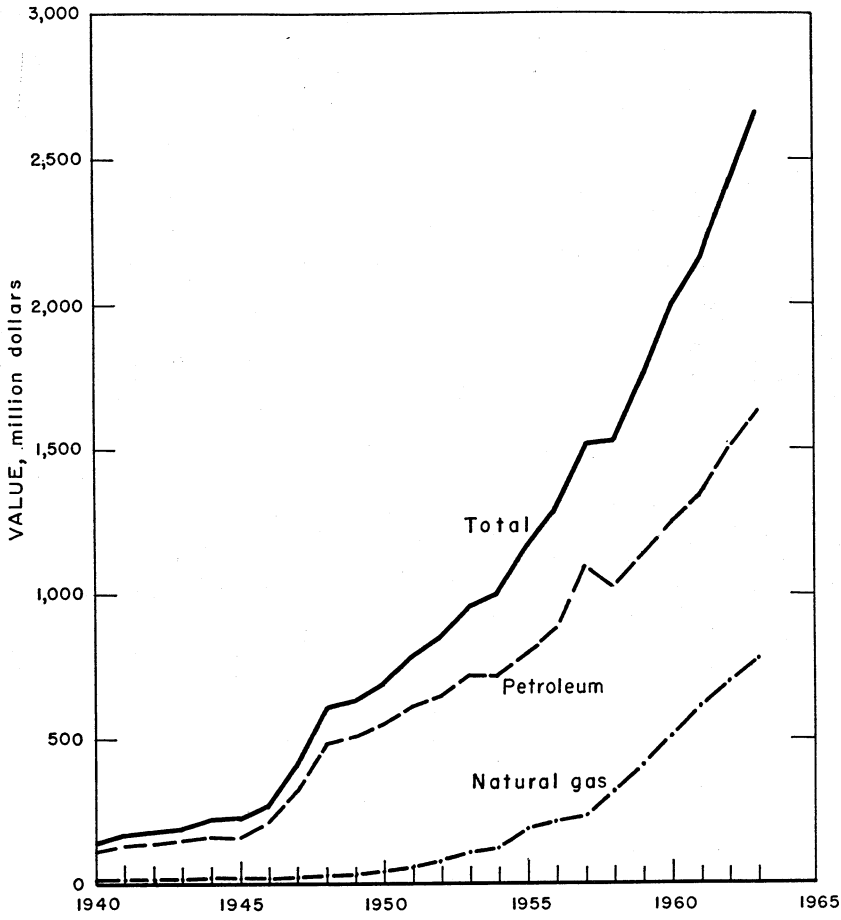


FIGURE 1.—Value of petroleum, natural gas, and total value of mineral production in Louisiana, 1940–63.

change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Trends and Developments.—Construction of new plants and additions to existing petrochemical plants, natural gasoline plants, and refineries continued at a high level throughout the year. The Louisiana State Board of Commerce & Industry approved ad valorem tax exemptions on a total investment of $245 million in applications for new manufacturing plants and expansions of existing plants; applications approved in 1962 for new industrial facilities totaled $131 million. About 80 percent of the 1963 total investment approved was for plants of power, fuel, chemical, and mineral industries. Largest of the ap-

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$1,037,742	1958	$1,520,764
1953	1,100,553	1959	1,787,613
1954	1,090,970	1960	1,987,995
1955	1,261,450	1961	2,138,626
1956	1,388,906	1962	2,358,478
1957	1,502,162	1963	2,589,763

proved applications were $25.3 million for the Louisiana Power & Light Co. plant at Laplace, $11.7 million for the Oklahoma Cement Co. plant at New Orleans, $11.5 million for Dow Chemical Co. at Plaquemine, $11.4 million for Shell Oil Co. at its Norco refinery, and $9.8 million for the Shell Oil Co. gas processing plant at Gibson and fractionating unit at Geismar.

Impressive plant additions were made on the State's two principal waterways. On the Mississippi River at Baton Rouge, Humble Oil & Refining Co., together with Reynolds Metals Co., completed facilities costing $10.5 million to produce and calcine petroleum coke. Humble also announced plans to build additional refining facilities to increase fluid catalytic cracking and to improve light oils and jet fuels. Ethyl Corp. completed a $1.6 million plant to produce chlorine and caustic soda. Foster Grant Co. and Allied Chemical Co. each were constructing an additional chemical plant. Big Three Welding Equipment Co. was constructing a $1.7 million plant to produce oxygen, nitrogen, and argon.

A combine of 29 oil companies will build Louisiana's largest gas processing plant at Gibson and send the recovered liquids by pipeline to a planned fractionating plant at Geismar, already the site of seven active and one proposed plants.

At Plaquemine and Gramercy, also on the Mississippi River, Dow Chemical Co., and Kaiser Aluminum & Chemical Corp., respectively, announced substantial plant additions.

In the New Orleans area, the huge Michoud plant of the National Aeronautics & Space Administration which manufactures booster engines for the Saturn space vehicle, received substantial additional appropriations for production facilities at Michoud and for testing facilities in Hancock County, Miss. Other important plant construction in progress in the New Orleans area included the Oklahoma Portland Cement Co. $12 million plant on the Michoud ship canal; E. I. du Pont de Nemours & Co., Inc., $20 million plant at Laplace; and the American Cyanamid Co. plant expansion at Avondale.

At Lake Charles, on the Calcasieu waterway, Cities Service Oil Co. enlarged its petrochemical complex by installing a butyl rubber plant with an ultimate capacity of 35,000 tons yearly. Olin Mathieson Chemical Corp. was constructing additional facilities to produce chlorine and caustic soda.

Elsewhere in the State, Olin Mathieson Chemical Corp. was making substantial additions to its pulp and paper plant at West Monroe;

Crown Zellerbach started a $40 million pulp and paper mill at St. Francisville.

Discovery of 46 oilfields and gasfields (34 onshore and 12 offshore) ranked Louisiana first in the Nation in added reserves of gas and made substantial additions to oil reserves. To provide for rapid development and marketing of new gas supplies, the industry added new facilities consisting of six gas processing plants completed or under construction and more storage space in salt dome caverns for the recovered plant liquids. A major products pipeline was completed for transporting these fuels through and from the State to eastern seaboard markets. Additional pipelines were built or planned to connect with offshore gas supplies.

The salt industry made significant additions in mining and chemical plants. In St. Mary Parish, a new salt mine was under development at Cote Blanche salt dome. This will bring a total of five coastal domes and one interior dome into production. New facilities to produce chlorine and other chemicals from salt were completed at Baton Rouge and planned at Geismar and Lake Charles.

The Mississippi River is one of the greatest industrial attractions to the Baton Rouge-New Orleans area. The river provides the Nation's largest fresh-water supply, with an annual flow of over 300 billion gallons a day—more water than is used in the entire Nation. The river is navigable for large oceangoing vessels as far as Baton Rouge and provides barge transportation to stations on the Mississippi, Ohio, Illinois, and Missouri Rivers. The $95 millon Mississippi River-Gulf Outlet, which shortens the shipping distance between New Orleans and the Gulf by 50 miles, was opened officially in July to ship traffic. Started in 1958, the channel was dredged to interim dimensions, 36-foot-deep and 250-foot-wide. When finished in 1969, the channel will be dredged to full project width of 500 feet. The new Gulf Outlet is expected to create a surge of industrial development east of New Orleans.

Other waterway projects, designed to promote industrial growth in the Baton Rouge-New Orleans area, were: The Barataria Waterway which extends from the Intracoastal Waterway near New Orleans to the Gulf of Mexico at Grande Isle. Construction of this $1.6 million waterway began in 1960. The $15 million Old River lock northwest of Baton Rouge is designed to prevent the main flow of the Mississippi River from moving into the Atchafalaya River and altering the present system of navigation.

Elsewhere in the State, the U.S. Army Corps of Engineers, Vicksburg District, was preparing a feasibility report culminating a 4-year study of navigation and other improvements on the Red River from Shreveport to the Mississippi River.

Survey work was completed on the Toledo Bend Dam and reservoir on the Sabine River and contracts were submitted for construction and for installation of hydroelectric facilities. Completion of the $60 million project was scheduled for 1966.

To keep pace with industrial expansion, Gulf States Utilities completed a $19.6 million expansion of its Sunshine plant, Iberville Parish. The added unit, a 220,000-kilowatt turbine generator, will supply elec-

tric power to the Baton Rouge area. Louisiana Power & Light Co. started constructing a second computer-controlled generating unit at its Little Gypsy steam-electric generating station near Laplace on the Mississippi River. The second unit, which will cost about $26 million and will have a capacity of 400,000 kilowatts, was scheduled for completion by the end of 1965. Steam generation at the two new plants was by gas fuel.

The Federal Power Commission reported that the total 14,839 million kilowatt-hours generated in 1963 by all Louisiana plants increased 9.3 percent compared with 1962 whereas the national increase for 1963 was 7.3 percent. Louisiana's 1963 electric output was about 1.6 percent of the national output—unchanged from 1962.

Legislation.—At yearend, the Secretary of the Interior released a Department of Justice ruling which holds that lands formed off the coast of Louisiana belong to the State. These lands, known as "Mudlumps", are islands formed from upswellings of clay near the mouth of the Mississippi River passes. They are important because they include 11,821 acres leased for oil and gas exploration by the Federal Government and of 29 separate leases 13 currently produce oil and gas. Ownership of these lands, which have been formed since Louisiana was admitted to the Union in 1812, has been in controversy for almost 10 years. The issue was whether these lands formed between the statehood date and the 1953 Submerged Lands Act were included in the grant of that Act.

The dispute concerning ownership of mineral rights in Gulf Coast tidelands remained unsettled pending completion of the coastal boundary study.

The Federal Power Commission modified its opinion of February 6 in which it ruled that acquisition of natural gas in the form of a leasehold purchase by a pipeline company from producers in the Rayne field was subject to its jurisdiction. In the modified opinion, FPC granted the parties opportunity to obtain certificates for gas sales already consummated. The case dates back to 1957 when the producers applied for FPC authority to sell Rayne field gas to a pipeline company at 23.9 cents per thousand cubic feet, and the pipeline company sought authority to build facilities to take the gas.

Employment and Injuries.—Employment in Louisiana's petroleum industry in 1963 was 84,450 workers—100 less than in 1962. In mineral production, including fuels (establishments with four or more employees), employment declined about 1 percent. Oil and gas operations provided 92 percent of employment and 93 percent of wages derived from mineral industries in 1963. Reported employment in Louisiana's total industry group in 1963 averaged 561,404 workers—an increase of about 3 percent.

The 6-month-old labor strike at the Shell Oil Co. and Shell Chemical Co. plants at Norco ended February 17 when members of the Independent Oil & Chemical Workers Union voted to accept the company's proposed terms. These terms included (1) termination of 234 maintenance and operation personnel at the refinery and 8 at the chemical plant, (2) a 5-percent wage increase for returning workers, (3) sever-

747-416—64——32

TABLE 3.—Employment and wages in the mineral industries [1]

Activity	Average number of workers		Total wages and salaries (thousands)	
	1962	1963 [2]	1962	1963 [2]
Crude petroleum production, natural gas and natural gas liquids	19,592	19,241	$142,306	$146,989
Oil and gas field contract services [3]	20,609	20,503	121,212	124,753
Sand and gravel quarries, pits, and dredges	1,296	1,242	5,072	5,213
Salt mines	801	847	4,320	4,565
Nonmetallic minerals [4]	1,427	1,305	10,384	9,935
Total	43,725	43,138	283,294	291,455

[1] The Louisiana Employment Security Law covers four or more employees.
[2] Preliminary figures.
[3] Includes approximately 3,300 formerly in service industries. The additional item is geophysical services.
[4] Mainly sulfur, excludes shell production workers.

Source: Louisiana State Department of Labor, Division of Employment Security.

ance pay for workers terminated, and (4) bonus pay for certain retirees.

At Baton Rouge, Humble Oil & Refining Co. scheduled a part reduction of a 400-employee surplus in June through an early retirement plan. The refinery employs 4,750 people.

One oilfield worker was killed in Lafayette Parish by falling while climbing to the deck of an oil rig.

Two injuries and one death occurred in two separate oilfield accidents in Plaquemines Parish. At the Tiger Pass oilfield, gas from a drilling well caught fire and two of the crew on the drilling barge sustained burns and were hospitalized. One rig worker died of injuries received at Nairn in December 1962.

At Hackberry, Cameron Parish, one worker was killed and several others received minor burns from a gas explosion on a drilling rig.

TABLE 4.—Total wage and salaried workers in petroleum production, refining, and related industries

Year	Crude petroleum and natural gas production	Petroleum refining [1]	Pipeline transportation (except natural gas)	Gas utilities	Petroleum bulk tank stations	Retail filling stations	Chemicals manufactured as by-products of petroleum or used in the refining of petroleum [2]	Total
1954–58 (average)	38,330	15,660	1,440	5,490	4,250	7,880	11,880	84,930
1959	42,100	13,500	1,320	6,380	4,440	9,000	12,100	88,840
1960	[3] 40,150	13,350	1,250	6,400	4,300	8,850	11,650	85,950
1961	40,300	12,800	1,150	6,350	4,000	8,700	12,350	85,650
1962	40,400	12,000	1,000	6,250	3,900	8,900	12,100	84,550
1963 [4]	40,400	11,300	950	6,200	4,100	9,300	12,200	84,450

[1] Employment in petroleum refineries and petrochemicals manufactured in petroleum refineries.
[2] Employment in petrochemical manufacturing facilities located outside petroleum refineries.
[3] Includes 3,300 formerly in service industries.
[4] Preliminary figures.

Source: Louisiana State Department of Labor, Division of Employment Security.

TABLE 5.—Value of construction contracts awarded

(Thousand dollars)

Type	1960	1961	1962	1963	Percent change from 1962
Residential [1]	$206,129	$219,412	$271,162	$344,422	+27.0
Nonresidential [2]	182,227	175,226	192,929	216,579	+12.3
Public works and utilities	190,522	194,043	194,836	377,909	+94.0
Total	578,878	588,681	658,927	938,910	+42.5

[1] Includes apartments, hotels, dormitories, and one- and two-family dwellings.
[2] Includes commercial, manufacturing, educational, and other nonresidential buildings.

Source: Louisiana Business Review, Dodge Statistical Research Service. V. 27, No. 2, February 1964, p. 14.

Two lives were lost near Raceland, Lafourche Parish, when an oil rig fell over during high winds.

At New Iberia, Iberia Parish, a power shovel operator in a salt mine was struck and killed when a huge chunk of salt fell 60 feet.

Three plant workers sustained first- and second-degree burns and two neighbors received minor injuries from a gas explosion and fire at the Dow Chemical Co., Plaquemine plant, Iberville Parish.

Three construction workers, employed by an offshore drilling company, were injured by a falling pipe while working at the National Aeronautics & Space Administration plant at Michoud, near New Orleans.

Three workers were injured slightly from an explosion and fire of a gas storage tank at the Fortier plant of American Cyanamid Co. at Avondale, Jefferson Parish.

Water.—Water problems including long-range supply, quality, pollution, re-use, and treatment received increasing attention from Federal and State agencies and private research institutions. The Federal Bureau of Mines conducted a nationwide canvass of the mineral industry to obtain 1962 water use data. The following tables are based on results of the survey.

TABLE 6.—Water use in the mineral industry in 1962

(Million gallons)

	New water	Water recirculated	Total water use	Water discharged	Water consumed
Nonmetal mines and mills	13,576	1,230	14,806	11,728	1,848
Sand and gravel mines	6,414	6,651	13,065	6,177	237
Natural gas processing plants	54,499	131,263	185,762	51,194	3,305
Petroleum	4,705	861	5,566	15	4,690
Total	79,194	140,005	219,199	69,114	10,080

TABLE 7.—Water usage of wells drilled by rotary tools, by parishes, in 1962

(Barrels)

Parishes	Number of wells	Total footage	Fresh water used	Saline water used	Other water used	Total barrels/ foot
Acadia	100	940,263	2,812,864			2.99
Allen	7	63,754	91,600			1.44
Ascension	13	120,683	241,350			2.00
Assumption	20	248,845	153,150			.62
Avoyelles	35	341,567	170,800			.50
Beauregard	31	286,479	359,839			1.26
Bienville	14	99,851	110,833			1.11
Bossier	96	323,055	591,100			1.83
Caddo	534	993,973	1,987,900			2.00
Calcasieu	61	479,497	628,230			1.31
Caldwell	12	48,192	53,000			1.10
Cameron	202	2,224,459	4,083,477	3,022,050	167,000	3.27
Catahoula	160	740,348	591,800			.80
Claiborne	19	177,765	266,650			1.50
Concordia	124	751,726	465,100			.62
De Soto	114	324,850	318,800			.98
East Baton Rouge	5	51,082	102,150			2.00
East Carroll	1	2,389	3,580			1.50
Evangeline	26	234,518	67,500			.29
Franklin	16	72,615	80,270			1.11
Grant	21	48,373	48,400			1.00
Iberia	48	537,113	251,738	333		.47
Iberville	51	380,432	1,110,250			2.92
Jackson	18	110,349	110,400			1.00
Jefferson	162	1,640,275	2,305,655	1,973,735	600	2.61
Jefferson Davis	36	376,532	1,887,800			5.01
Lafayette	18	217,422	1,071,700			4.93
Lafourche	335	3,652,492	2,913,469	576,764	405,000	1.07
La Salle	115	330,635	127,650			.39
Lincoln	45	351,962	1,499,100			4.26
Livingston	5	48,378	72,600			1.50
Madison	3	15,005	16,685			1.11
Morehouse	33	75,885	113,800			1.50
Natchitoches	16	67,530	101,300			1.50
Orleans	2	17,463	26,200			1.50
Ouachita	107	337,079	540,000			1.60
Plaquemines	516	4,991,105	3,597,911	698,192	2,620,250	1.39
Pointe Coupee	6	63,055	159,472			2.53
Rapides	15	99,984	92,980			.93
Red River	13	36,292	47,200			1.30
Richland	12	41,182	56,832			1.38
Sabine	449	1,479,516	3,400,600			2.30
St. Bernard	11	100,125	48,549	17,025		.65
St. Charles	23	258,643	111,900	534,350		2.50
St. Helena	1	10,508	10,500			1.00
St. James	5	47,051	32,550			.69
St. John the Baptist	7	73,157	109,750			1.50
St. Landry	54	518,327	971,075			1.87
St. Martin	67	645,024	1,607,328			2.49
St. Mary	155	2,107,715	2,391,292	2,377,400	20,500	2.27
St. Tammany	2	22,120	67,200			3.04
Tangipahoa	1	12,285	24,550			2.00
Tensas	89	768,872	353,457			.46
Terrebonne	311	3,835,581	3,748,347	5,327,171	120,600	2.40
Union	175	467,751	1,747,251			3.74
Vermilion	222	2,704,779	3,184,852	6,865,400	462,150	3.89
Vernon	9	109,523	164,300			1.50
Webster	46	238,318	347,611			1.46
West Feliciana	1	15,071	15,000			1.00
Winn	179	253,491	253,500			1.00
Total	4,974	35,632,311	47,920,747	21,392,420	3,796,100	2.05

TABLE 8.—Barrels of water injected in secondary recovery operations in 1962

Water source by geologic period	New water injected			Injected water produced from oil wells			Total water injected
	Fresh	Saline	Total	Fresh	Saline	Total	
Cretaceous		9,037,605	9,037,605		16,113,204	16,113,204	25,150,809
Tertiary	14,529,469	14,200,889	28,730,358		4,382,791	4,382,791	33,113,149
Total	14,529,469	23,238,494	37,767,963		20,495,995	20,495,995	58,263,958
Surface water (part saline and brackish)							1,151,278
Total water injected							59,415,236

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Louisiana continued to be a leading domestic producer of crude petroleum and natural gas and a major supplier of natural gas liquids and refined petroleum products. The State also had a relatively high rate of activity in all branches of the oil and gas industry. At year-end, there were 1,109 oil and gasfields in the State containing 35,596 wells capable of producing oil and/or gas.

Intensive leasing by major oil companies in the Louisiana Gulf Coast continued. Smaller companies specialized on farmouts and were credited with most of the onshore new field discoveries in 1963.

Leasing activity in north Louisiana remained fairly stable; geologic areas of most interest were the Wilcox, Hosston-Cotton Valley, and Saratoga-Annona chalk trends. Leasing in south Louisiana was active although no large acreage blocks were acquired.

The State Mineral Board adopted a new policy for lease sales of public lands and water bottoms by holding a sale each month. On 11 sales in 1963, bids were accepted on 187,722 acres for a total $38,364,000, averaging about $204 per acre, 2.5 times the unit price of 1962. There were no Federal lease sales of offshore areas in 1963.

Exploration, Development, and Reserves.—Louisiana scored impressive gains in oil and gas reserves as the industry maintained a relatively high discovery rate. Statewide drilling of 5,754 wells (development and exploratory) was 827 more than in 1962 and proved 63 percent productive; Statewide drilling of 1,193 exploratory wells was 113 more than in 1962 and proved 17 percent productive (25 percent productive in 1962). Inland drilling of 930 exploratory wells proved 16 percent productive and opened 34 fields—5 oil and 3 gas discoveries in north Louisiana and 13 oil and 13 gas discoveries in south Louisiana.

Despite continued depressed oil markets and mounting costs of drilling, the offshore oil interests drilled 263 exploratory wells (21 percent productive) and discovered 12 fields (4 oil and 8 gas) compared with 14 fields in 1962.

The Louisiana Department of Conservation granted 6,360 permits to drill during the year, 664 more than in 1962. Abandoned wells totaled 997, compared with 857 in 1962.

North Louisiana (26 parishes) had a record year in number of development and exploratory wells drilled. Development drilling was most intensive in the Wilcox trend (Eocene age) and Saratoga-Annona chalk (Upper Cretaceous) of Sabine and Caddo Parishes.

TABLE 9.—Oil and gas well drilling and total crew-weeks spent in geophysical oil and gas prospecting in 1963

Location	Drilling							Geophysical, crew-weeks		
	Proved field wells			Exploratory wells			Total	Gravity meter method	Reflection seismograph method	Total
	Oil	Gas	Dry	Oil	Gas	Dry				
Parish:										
Acadia	10	16	23	------	1	16	66	----------	89	89
Allen	3	1	------	------	------	2	6	----------	11	11
Ascension	1	2	2	1	------	4	10	----------	----------	----------
Assumption	2	2	4	1	------	9	18	----------	53	53
Avoyelles	1	------	2	11	------	43	57	----------	16	16
Beauregard	6	------	6	1	------	6	19	----------	54	54
Bienville	1	5	11	------	------	1	18	----------	17	17
Bossier	16	5	14	4	------	6	45	----------	27	27
Caddo	764	4	52	2	1	2	825	----------	6	6
Calcasieu	20	8	13	1	2	20	64	----------	90	90
Caldwell	------	1	1	------	1	11	14	----------	12	12
Cameron	67	29	37	1	5	19	158	----------	107	107
Catahoula	38	------	75	3	------	79	195	----------	8	8
Claiborne	7	7	6	------	1	2	23	----------	24	24
Concordia	41	------	43	8	------	80	172	----------	3	3
De Soto	13	18	27	3	1	4	66	----------	7	7
East Baton Rouge	2	------	1	------	------	3	6	----------	1	1
East Carroll	------	------	------	------	------	------	------	----------	1	1
East Feliciana	------	------	------	------	------	------	------	----------	6	6
Evangeline	1	1	6	------	1	5	14	----------	12	12
Franklin	------	------	6	------	------	5	11	----------	2	2
Grant	11	------	6	------	------	7	24	----------	29	29
Iberia	17	9	6	------	------	7	39	----------	84	84
Iberville	47	2	9	------	1	11	70	----------	12	12
Jackson	------	6	3	------	3	6	18	----------	7	7
Jefferson	67	1	21	1	1	24	115	----------	39	39
Jefferson Davis	8	6	6	1	2	11	34	----------	43	43
Lafayette	1	5	7	------	4	3	20	----------	75	75
Lafourche	128	30	32	1	8	33	232	40	95	135
La Salle	76	3	59	4	------	21	163	----------	9	9
Lincoln	------	14	7	------	2	1	24	----------	6	6
Madison	------	------	------	------	------	------	------	----------	2	2
Morehouse	------	22	11	------	------	------	33	----------	----------	----------
Natchitoches	2	------	------	------	------	19	21	----------	64	64
Ouachita	------	73	9	------	2	2	86	----------	2	2
Plaquemines	195	24	36	9	4	47	315	----------	80	80
Pointe Coupee	6	1	2	2	------	3	14	----------	5	5
Rapides	25	------	32	1	------	20	78	----------	11	11
Red River	4	------	2	------	------	4	10	----------	21	21
Richland	1	------	5	------	1	3	10	----------	6	6
Sabine	465	2	294	8	1	12	782	----------	21	21
St. Bernard	28	2	------	3	3	23	59	----------	89	89
St. Charles	14	2	12	2	2	11	43	----------	45	45
St. Helena	------	------	------	------	------	1	1	----------	15	15
St. James	9	2	------	1	------	6	18	----------	11	11
St. John the Baptist	------	1	2	1	------	9	13	----------	3	3
St. Landry	21	8	18	------	2	12	61	----------	9	9
St. Martin	50	7	23	1	2	19	102	----------	50	50
St. Mary	101	22	14	------	------	20	157	----------	85	85
St. Tammany	------	------	------	------	------	2	2	----------	----------	----------
Tangipahoa	1	------	------	------	------	1	2	----------	----------	----------
Tensas	32	2	23	4	------	16	77	----------	1	1
Terrebonne	140	38	39	8	6	29	260	----------	171	171
Union	------	153	14	------	1	12	180	----------	26	26
Vermilion	14	16	24	1	3	24	82	----------	196	196
Vernon	------	------	------	------	------	4	4	----------	----------	----------
Webster	2	3	6	------	2	4	17	----------	31	31
West Baton Rouge	------	------	------	------	------	------	------	----------	1	1
Winn	21	------	24	------	------	39	84	----------	53	53
West Feliciana	------	------	------	------	------	------	------	----------	8	8
Total: 1963	2,479	553	1,075	84	63	783	5,037	40	1,951	1,991
1962	1,877	540	1,035	87	96	688	4,323	14	2,586	2,600

TABLE 9.—Oil and gas well drilling and total crew-weeks spent in geophysical oil and gas prospecting in 1963—Continued

Location	Drilling							Geophysical, crew-weeks		
	Proved field wells			Exploratory wells			Total	Gravity meter method	Reflection seismograph method	Total
	Oil	Gas	Dry	Oil	Gas	Dry				
Offshore:										
Bay Marchand	17	1	8			1	27			
Breton Sound	17	4	7	1		9	38	8	34	42
Cameron, East	1	2	1		3	14	21		32	32
Cameron, West	2	3	4		1	13	23		20	20
Chandeleur Sound				1		4	5		40	40
Delta, West	75	6	9	9	3	33	135		55	55
Eugene Island	12	1	11		1	19	44		49	49
Grand Isle	28	2	2	5		17	54		40	40
Main Pass	20	7	5	1		15	48	43	72	115
Marsh Island, South	13	16	11	8	5	23	76		43	43
Pelto, South	10		8	1		2	21			
Ship Shoal	17	8	5	1	2	17	50		43	43
South Pass	45		5	1		5	56	38	29	67
Timbalier, South	46	1	10	3	1	15	76		49	49
Vermilion		8	6	1	8	20	43		54	54
Total: 1963	303	59	92	32	24	207	717	89	560	649
1962	261	67	67	43	45	121	604	132	370	502
Grand total: 1963	2,782	612	1,167	116	87	990	5,754	129	2,511	2,640
1962	2,138	607	1,102	130	141	809	4,927	146	2,956	3,102

Source: International Oil Scouts Association. International Oil and Gas Development. Austin, Texas, vol. 33, 1963.

Exploratory drilling was most active in the Wilcox area of Caldwell, Catahoula, Concordia, Grant, La Salle, Rapides, and Winn Parishes; in the Tuscaloosa area of Tensas, Madison and Franklin Parishes; in the Saratoga-Annona chalk area of Natchitoches and Sabine Parishes; and in the Paluxy area of De Soto and Red River Parishes. The deepest well ever drilled in north Louisiana was Shell Oil Co. No. 1 Tremont in Jackson Parish. This well (dry) reached the Smackover limestone at a depth of 16,706 feet.

Drilling in south Louisiana (38 parishes onshore) continued to gain for both development wells and field wells. The Southwest District (area onshore west of Atchafalaya River) was most active in exploratory drilling. Shallow Eocene Wilcox tests in Avoyelles and Rapides Parishes discovered nine oilfields in Avoyelles Parish.

A most important discovery well drilled by J. P. Owen, Hoffpauir No. 1, near Crowley, Acadia Parish, opened the Lawson field. By yearend, the field had been extended about 2 miles, further drilling was in progress, and leasing was extensive.

In St. Bernard Parish, discovery of Half Moon Lake field and a successful drilling program in neighboring Eloi Bay field stimulated leasing and drilling on State water-bottom acreage in the Chandeleur Sound and Breton Sound areas. Multiple-pay sands of upper Miocene age, at depths of less than 9,000 feet, were characteristic of the trend.

The deepest well completed in 1963 was the Texaco No. 6 Lake Barre Unit 44 well in Terrebonne Parish. This well, completed in the Miocene sand at 19,880 to 19,914 feet, tested 340 barrels of oil (28.7

gravity) and 252,000 cubic feet of gas daily. Other wells drilled below 16,000 feet usually produce gas or condensate only.

Geophysical prospecting was most active in the Southwest District but declined overall in south Louisiana.

Exploratory drilling in the offshore area (16 Continental Shelf areas) moved farther seaward where most of the exploratory effort was made in Pliocene sediments. Most of the development wells were drilled on near-shore structures where Miocene formations which hold the largest percentage of proved oil reserves of south Louisiana.

All of the offshore oil discoveries were on new structures, most of which were leased at the last Federal lease sale in 1962.

A significant addition to reserves was made in Block 14 field, Vermilion area, where 350 feet of deeper gas sand (lower Miocene) was found by drilling 3,000 feet below the known field sand at 12,000 feet.

Demand for deep-water drilling rigs continued as four offshore companies completed or contracted to construct four such rigs. Two rigs were to be of the tripod design, nonfloating, and capable of operating in 250 feet of water and drilling to depths of 20,000 feet. A third drilling company completed a V-shape unit, the Ocean Driller, designed to operate from either a floating position in deep water or resting on the ocean floor in water up to 40 feet deep. It also was capable of drilling to depths of 20,000 feet. A fourth drilling company was planning to construct a 275-foot long catamaran (two hulls) craft. The oceangoing catamaran was to be self-propelled and equipped to make above-water or subsea completions without shifting the drilling machinery. The CATC group (Continental Oil Co., Atlantic Refining Co., Tidewater Oil Co., and Cities Service Oil Co.) accomplished the first submarine pipeline connection. The connection was made in the Grand Isle area, 130 feet under water.

According to The Oil and Gas Journal, 33.9 million feet of hole was drilled in the State during the year, or 5.4 percent less than the footage drilled in 1962. The number of drilling rigs operating offshore averaged 78 in 1963 and 59 in 1962; for the entire State, the average number was 265 in 1963 and 261 in 1962.

Proved recoverable reserves of crude petroleum, natural gas, and natural gas liquids in Louisiana reached a new high despite increased withdrawals of each. Much of the added reserves came from extensions and revisions of previous estimates involving pools and fields discovered before 1963. Slightly more than two-thirds of the total additions to crude petroleum reserves was attributed to extensions and revisions, and the remainder to new discoveries. Extensions and revisions of reserves in south Louisiana accounted for a major part of the additions for the entire Nation. State crude petroleum reserves increased by 2 million barrels to a new record total of 5,089 million barrels (16 percent of the Nation's total oil reserves). According to The Oil & Gas Journal, about 40 percent of the State crude petroleum reserve was offshore, as compared with 38 percent in 1962. Natural gas reserves increased 3.8 trillion cubic feet (equivalent to the Nation's net increase) to a new record total of 75.4 trillion cubic feet (27 percent of U.S. total). Natural gas liquids reserve increased 143 million barrels (40 percent of U.S. net increase) to a new record total of 1,841 million barrels (24 percent of U.S. total).

TABLE 10.—Crude petroleum, natural gas, and natural gas liquids production and addition to reserves

Year	Crude petroleum (million barrels)		Natural gas (billion cubic feet)		Natural gas liquids (million barrels)	
	Production	Net additions to reserves	Production	Net additions to reserves	Production	Net additions to reserves
1954	247	202	1,399	2,341	23	71
1955	271	294	1,680	5,636	26	52
1956	299	420	1,886	2,618	26	79
1957	330	182	2,079	6,382	26	4
1958	314	186	2,452	3,676	28	177
1959	363	616	2,670	4,742	33	162
1960	401	125	2,988	3,532	35	75
1961	425	146	3,272	2,643	41	61
1962	477	155	3,525	5,906	45	204
1963	[1] 523	2	3,928	3,821	54	143
	Total proved reserves by Dec. 31, 1963					
1963	5,089		75,365		1,841	

[1] Preliminary figure.

Source: Reserves based on American Gas Association, American Petroleum Institute, and Canadian Petroleum Association, Proved Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas, v. 8-18, 1953-63. Production figures from Bureau of Mines.

Carbon Black.—Output of carbon black from natural gas and petroleum distillates gained about 7 percent. The product was mainly used as an additive in rubber manufacturing.

TABLE 11.—Carbon black production

Year	Million pounds	Year	Million pounds
1954–58 (average)	489	1961	583
1959	599	1962	608
1960	631	1963	649

Natural Gas.—Marketed production of natural gas continued a strong growth trend for the 18th consecutive year and Louisiana retained second position in the United States as a supplier of natural gas. National demand for gas as a fuel for heating and power and as a raw material for petrochemicals grew rapidly. Both new and existing reserves continued entry into the growing gas market as gas transmission companies installed more pipeline facilities and entered long-term purchase contracts for withdrawal and marketing of the huge gas supplies.

Texas Eastern Transmission Co. announced purchase of 4.4 trillion cubic feet of new gas supplies from south Louisiana holdings of Gulf Oil Corp. Gulf, which will deliver the gas over a 26-year period, started constructing a 20-inch transmission line from West Delta Block 27 to Venice in Plaquemines Parish where it plans construction of a large gas-processing plant to recover condensable liquids. From this plant, Texas Eastern will transmit the gas through a new 30-inch line 175 miles to its existing transmission system which supplies the New York market. First delivery of gas is scheduled for November

TABLE 12.—Natural gas data

(Million cubic feet)

Year	Withdrawals [1]			Marketed production [2]	Value at wells (thousands)	Disposition	
	From gas wells	From oil wells	Total			Repressuring	Vented and wasted [3]
1954–58 (average)	1,728,800	445,000	2,173,800	1,899,209	$215,701	203,139	71,452
1959	2,442,000	514,000	2,956,000	2,670,271	411,222	186,599	99,130
1960	2,691,000	622,000	3,313,000	2,988,414	511,019	219,411	105,145
1961	2,930,100	640,700	3,570,800	3,271,857	611,837	201,989	96,954
1962	3,124,000	730,000	3,854,000	3,525,456	694,515	221,167	107,377
1963	3,540,100	710,000	4,250,100	3,928,427	777,829	212,116	109,557

[1] Marketed production plus quantities used in repressuring, vented, and wasted.
[2] Comprises gas sold or consumed by producers, including losses in transmission, amounts added to storage, and increases in gas in pipelines.
[3] Partly estimated. Includes direct waste on producing properties and residue blown to the air.

1964. Gulf Oil Corp. also initiated a $12.5 million pipeline construction program, part of which was to connect the Blocks 176, 135, and 131 fields in the area south of New Orleans.

In another record transaction, Columbia Gulf Transmission Co. filed application with Federal Power Commission to purchase 6.1 trillion cubic feet of gas reserves held by Humble Oil & Refining Co. and Isaac Arnold, et al., in five south Louisiana fields. Cost of new pipeline and compressor station facilities to handle the gas was estimated at $49 million.

Twenty-five companies reached agreement to construct a 400-mile, 30-inch pipeline to deliver oil and gas from offshore fields in Zone 4. This includes fields in Federal waters 30 to 100 miles offshore. Tentative plans called for laying the line in a huge arc in the Gulf about 70 miles from shore and providing a central connecting line to Gibson, La., a distance of about 90 miles. At Gibson, the gas would be processed through a large gasoline plant, proposed by 29 companies, and then sold to any of several transmission companies who have lines into or near the area.

The industry had one active and one planned underground gas storage project in Louisiana in 1963. South Louisiana Production Co. operated a gas storage reservoir in Holly field, De Soto Parish; total storage capacity (1.5 trillion cubic feet) of the reservoir represented 1 trillion cubic feet "working" storage and a half trillion cubic feet "cushion" storage. Southdown Production Co. was planning gas storage in the Old Grand Cane field and also in De Soto Parish. The plan calls for storing gas from several fields in the Grand Cane reservoir during the low-demand season and withdrawal of gas as required by the company's pipeline serving central Louisiana areas.

Natural Gas Liquids.—Louisiana again ranked second in the Nation as a producer of natural gas liquids and registered the fourth largest increase in daily processing capacity. New plants and expansions added in 1963 raised the State's daily processing capacity from 10.9 billion cubic feet to 11.4 billion cubic feet (21.5 percent of the Nation's total capacity).

Natural gasoline and cycle products were recovered by 111 gasoline plants and 15 recycling plants (108 gasoline and 16 recycling plants in

TABLE 13.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	755,891	$58,042	326,919	$14,598	1,082,810	$72,640
1959	846,110	60,295	540,046	25,877	1,386,156	86,172
1960	875,567	66,214	606,023	28,147	1,481,590	94,361
1961	931,176	61,714	806,559	33,214	1,737,735	94,928
1962	1,010,137	74,726	862,772	29,037	1,872,909	103,763
1963	1,143,707	81,332	1,113,670	41,043	2,257,377	122,375

1962) in 32 parishes. Increased output of total condensable liquids was attributed mainly to a gain in natural gas produced and processed. Prospects are that this trend will continue because demand for natural gas is rising and the Louisiana offshore is the most promising area for developing new gas reserves.

Recovery of condensable liquids gained about 21 percent and amounted to 13.4 percent of the Nation's annual total. Composition of the output was divided approximately equally between natural gasoline and LP gases. Consumption pattern and market development for the condensable liquids were widened aggressively to provide greater outlets for the fast-rising production. Some of the newer markets being developed were flame cultivation, crop drying, and fuel for internal combustion engines. New pipelines completed in recent years provided wider distribution of the fuel for the older domestic-use market. Newly developed low-cost refrigerated transport methods were opening new markets for both LP gases and liquefied methane.

In Louisiana, the petrochemical industry was a substantial consumer of natural gas liquids and there were indications that further growth of this market could be expected.

To provide for rapid development and marketing of new gas supplies, the industry continued constructing vast facilities for processing natural gas and for recovering, delivering, and storing the plant liquids.

Two-thirds of the 431-million-cubic-foot-per-day increase in processing capacity was credited to two south Louisiana plants: The new Atlantic Refining Co. refrigeration-absorption plant at Bayou Sale field near Franklin, St. Mary Parish (110-million-cubic-foot-per-day capacity) and Continental Oil Co. absorption unit near Grand Chenier, Cameron field, Cameron Parish (capacity increased by 185 million cubic feet per day).

In north Louisiana, Arkansas Louisiana Gas Co. started operating a 40-million-cubic-foot-per-day cycling unit on gas from the Cadeville Reservoir, Calhoun field, Ouachita Parish. Sun Oil Co. modernized its Delhi plant in Richland Parish. In south Louisiana, Pan American Petroleum Corp. closed two small adsorption plants—one at Church Point field, Acadia Parish, and one at Lewisburg field, St. Landry Parish.

Projects under construction in 1963, plus announced plans for new or expanded construction in 1964, indicated an anticipated growth of processing capacity in 1964 approximately four times that of 1963.

Shell Oil Co. and 28 other companies plan to build one of the world's largest gas-processing plants at Gibson. Processing capacity will be 950 million cubic feet per day of south Louisiana and offshore field gas moving through the lines of United Gas Co. and Transcontinental Gas Pipe Line Corp. The complete project will include a fractionator at Geismar on the Mississippi River to which the liquid stream from the Gibson (North Terrebonne) plant will be pumped through a pipeline for separation of the components.

New plant construction to process south Louisiana gas supplies was trending toward larger capacity, refrigeration-absorption systems with low-temperature operating ranges, fuller automation, and use of central fractionators. Central fractionators are located at sites more convenient for storage and transportation of the liquid components.

Development of storage techniques and storage facilities was improved to increase the availability of natural gas liquids and, in turn, to increase the market for natural gas liquids. Louisiana doubled its underground storage capacity in the past 5 years. Capacity, as reported by The Oil & Gas Journal survey, was 7.87 million barrels of natural gas liquids, plus 1.27 million barrels of ethylene storage, for a total capacity of 9.14 million barrels. The underground storage cavities, all in salt domes, were operated by 11 companies in 8 parishes. For future storage possibilities, above-ground refrigerated storage and frozen-earth pits promise to provide economical storage in areas where suitable salt domes do not exist.

In 1963, Wanda Petroleum Co. was washing a salt cavity for propane storage and was drilling another for butane storage in St. Martin Parish. Socony Mobil Oil Co., Goliad Division, was planning a salt-dome storage cavity for propane near Geismar, and Gulf Oil Co. was planning salt-dome storage for propane and butane at Venice, Plaquemines Parish.

Petroleum.—The petroleum industry in Louisiana established a new production record of 523 million barrels in 1963—second highest in the Nation. The gain of nearly 10 percent over 1962 came from new discoveries, both offshore and onshore.

To balance production with indicated demand, the State Conservation Commission adjusted petroleum allowables. Daily allowables, based on the Commission's formula, advanced from approximately 1,198,000 barrels at the first of the year to a peak of 1,292,000 barrels for the July–August period—largest allowable in the State's history. This was followed by a cut of 44,000 barrels per day, but the effect of

TABLE 14.—Crude petroleum production

(Thousand barrels and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954–58 (average)	292,155	$902,304	1962	477,153	$1,502,568
1959	362,666	1,145,569	1963 [1]	522,739	1,631,792
1960	400,832	1,258,138			
1961	424,962	1,338,160	1902–63	6,941,940	17,378,368

[1] Preliminary figures.

TABLE 15.—Crude petroleum production, indicated demand, and stocks, in 1963, by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks (end of month)	Month	Production	Indicated demand	Stocks (end of month)
January	42,925	42,751	22,797	September	42,019	43,683	22,929
February	39,493	40,405	21,885	October	43,573	44,894	21,608
March	44,385	42,928	23,342	November	43,622	43,808	21,422
April	43,081	43,074	23,349	December	45,034	45,032	21,424
May	44,682	45,265	22,766				
June	43,317	44,058	22,025	Total:			
July	44,818	44,078	22,765	1963	522,739	523,938	
August	45,790	43,962	24,593	1962	477,153	474,290	

new wells raised the allowable to 1,263,000 barrels for the November–December period.

Secondary recovery projects (water, gas, or other injections) accounted for 60 million barrels of petroleum, or 11 percent of the 1963 production.

According to a survey,[4] Louisiana had 9,677 oil wells classified as "stripper" wells. For 1962, stripper wells represented 37 percent of total oil wells, but only 2 percent of the annual production and 3 percent of the State's recoverable oil reserves. Thus, normal production decline from stripper wells was not expected to affect appreciably the State's productive capacity and reserves in the immediate future.

Refineries.—At the end of 1963, there were 14 petroleum refineries (1 partly active) in Louisiana. Total crude oil capacity (barrels per calendar day) was as follows: Operating, 825,050; standby, 8,500; and building, none. Cracking and reforming gasoline capacity (barrels daily) was as follows: Operating 282,835; standby, 6,900; and building, none.

Crude oil runs to refinery stills totaled 276 million barrels (3.3 million barrels more than in 1962) and represented about 53 percent of the State's annual production of crude oil.

Humble Oil & Refining Co. at Baton Rouge put on stream (February 1963) a delayed-coking unit to produce 1,000 tons of petroleum coke daily.

TABLE 16.—Number of producing oil wells and average production per well

Year	Number of producing wells Dec. 31	Average production per well per day (barrels)	Year	Number of producing wells Dec. 31	Average production per well per day (barrels)
1954–58 (average)	20,140	41.7	1961	24,740	47.1
1959	23,468	42.7	1962	26,382	49.6
1960	24,682	44.8	1963 [1]	27,638	51.8

[1] Preliminary figures.

[4] Interstate Oil Compact Commission. National Stripper Well Survey, Jan. 1, 1963. Oklahoma City, Okla., October 1963.

TABLE 17.—Production of crude petroleum by districts and selected fields

(Thousand barrels)

District and field [1]	1962	1963 [2]
Gulf Coast:		
Onshore: [3]		
Anse la Butte	1,600	1,437
Avery Island	2,714	2,696
Bastian Bay	2,568	3,369
Bateman Lake	2,835	2,765
Bay de Chene	2,541	2,706
Bay St. Elaine	8,198	7,925
Bayou Sale	6,677	7,307
Bully Camp	1,572	1,675
Caillou Island	19,828	20,425
Cox Bay	1,976	1,980
Delta Farms	3,018	2,974
Duck Lake	3,031	3,016
East & West White Lake	1,752	1,723
Erath	4,809	4,309
Garden Island	3,209	4,740
Golden Meadow	2,493	2,673
Grand Bay	5,613	6,347
Hackberry	5,791	7,522
Lafitte	4,236	4,850
Lake Barre	9,476	10,231
Lake Pelto	4,607	4,288
Lake Salvador	2,800	3,047
Lake Washington	10,621	10,506
Leeville	3,997	3,745
Little Lake	2,082	2,600
Main Pass Block 35	4,126	4,400
Paradis	2,453	2,395
Quarantine Bay	5,241	5,047
Romere Pass	2,925	3,069
South Pass Block 24	16,578	17,451
Timbalier Bay	14,124	16,948
Valentine	1,803	1,722
Venice	4,574	4,554
Vinton	1,801	1,805
Weeks Island	8,557	7,191
West Bay	7,432	7,615
West Cote Blanche	5,446	6,426
Gulf Coast—Continued		
Onshore—Continued		
West Lake Verret	1,515	1,633
Other	148,616	154,687
Total onshore	343,235	359,799
Offshore [3]		
Bay Marchand	17,233	26,452
Eugene Island	9,823	13,173
Grand Isle	13,743	14,955
Main Pass Block 69	8,592	8,861
Ship Shoal	5,517	5,527
South Pass Block 27	11,585	14,354
South Timbalier Block 131		1,770
Vermilion	2,154	930
West Delta Block	14,043	16,522
Other	4,918	5,625
Total offshore	87,608	108,169
Total Gulf Coast	430,843	467,968
Northern:		
Buckhorn	1,199	1,865
Caddo	5,704	6,199
Cotton Valley	3,430	3,708
Delhi	4,670	4,774
Haynesville	2,513	2,638
Lake St. John	2,046	1,973
Pendleton	2,022	3,340
Sligo	2,305	2,409
Other Northern	22,421	27,865
Total Northern	46,310	54,771
Total Louisiana	477,153	522,739

[1] Breakdown for individual fields from The Oil and Gas Journal.
[2] Preliminary figures.
[3] Some fields include onshore and offshore.

At its Lake Charles refinery, Cities Service Petroleum Co. began operating (March 1963) the first hydrocracking plant designed to convert residual oils with high sulfur content into a synthetic sweet crude oil equivalent. The process plant, known as an H-oil unit, with a designed initial capacity of 2,500 barrels of oil daily, reacts heavy, high-boiling-point residuum with hydrogen in presence of an active catalyst to remove sulfur, nitrogen, and organometallic compounds, simultaneously upgrading the stock treated. The treated oil then is processed into lighter petroleum products such as gasoline, heating oil, and diesel fuel. Vacuum distillation capacity of the Cities Service refinery was increased from 32,000 to 42,000 barrels per stream day.

Shell Oil Co. started expanding and modernizing its refinery at Norco to increase capacity by about one-third. Cost of the program will exceed $20 million and will be spread over a period of 2 years. New gasoline processing equipment included in the initial program

TABLE 18.—Crude petroleum production and estimated reserves in Louisiana offshore area

(Thousand barrels)

Offshore area	Number of wells		1962	1963		
	1962	1963	Crude petroleum	Crude petroleum	Cumulative total	Estimated reserve
Bay Marchand: Block 2 [1 2]	497	516	17,233	26,452	105,969	394,031
Belle Isle [2]	63	55	1,549	1,290	10,636	24,364
Caillou Island [1 2]	580	616	19,828	20,425	217,609	282,391
Eugene Island:						
Block 18	59	55	2,704	2,544	14,466	25,534
Block 32	31	31	979	950	9,047	15,953
Block 45	10	10	541	571	3,458	7,542
Block 100	10	17	1,009	825	2,954	17,046
Block 126 [1]	88	92	3,633	4,023	31,618	93,382
Block 128	47	39	1,938	2,018	13,065	26,935
Block 188	16	23	806	854	4,482	10,518
Block 208	38	36	1,548	1,388	4,511	30,489
Grand Isle:						
Block 16	165	190	7,176	8,770	30,634	144,366
Block 18	35	34	1,805	1,689	18,480	21,520
Block 47	85	87	4,762	4,496	23,048	36,952
Lake Washington [1 2]	435	423	10,621	10,506	94,947	205,053
Main Pass:						
Block 46	[3]	3	337	380	1,627	2,373
Block 69 [1]	207	191	8,592	8,861	70,137	129,863
Ship Shoal:						
Block 28	12	22	670	672	1,906	8,094
Block 107	37	45	1,926	2,976	5,768	34,232
Block 154	38	36	1,552	1,455	10,667	29,333
Block 176	23	23	1,027	1,096	3,664	18,336
South Pass:						
Block 24 [1 2]	571	580	16,578	17,451	192,318	307,682
Block 27 [1]	331	375	11,585	14,354	56,021	254,979
South Pelto: Block 20	16	22	572	839	2,017	17,983
Tiger Shoal	23	23	949	928	2,635	6,365
Timbalier Bay [1 2]	390	485	14,124	16,948	99,499	200,501
South Timbalier: Block 131	32	43	693	1,770	4,037	27,963
Vermilion:						
Block 14	31	41	1,769	930	3,846	28,154
Block 120	10	[3]	385	342	2,146	[3]
West Cameron:						
Block 45	38	37	984	1,063	5,677	19,323
Block 192	41	38	510	520	2,044	17,956
West Delta:						
Block 24	11	21	471	789	1,777	16,223
Block 30 [1]	289	418	12,046	16,522	59,853	340,147
Block 53 [2]	15	12	464	438	6,888	15,112
Totals	4,274	4,639	151,366	175,135	1,117,451	2,810,695

[1] Estimated ultimate recovery of 100 million barrels or more.
[2] Combined onshore and offshore.
[3] Not reported.

Source: The Oil and Gas Journal. V. 62, Jan. 27, 1964, pp. 161–162.

was a large distillation unit, a vacuum flasher, and several new conversion units. Shell will use the hydrocracking process in the modernization program.

Chemoil Corp. abandoned its plan to build a 40,000-barrel-per-day refinery between New Orleans and Baton Rouge.

To facilitate delivery of petroleum products from Gulf Coast refineries to southeastern and eastern seaboard markets, nine oil companies organized the Colonial Pipeline Co. and completed the largest products pipeline in the Nation. The $360 million line consists of 1,600 miles of mainline and 1,000 miles of spur lines ranging 30 to 36 inches in diameter and extends from Houston, Texas, through

Louisiana to New York City. Two of the 20 pump stations are located at Lake Charles and Baton Rouge. Designed delivery capacity of the line is 600,000 barrels of fuels daily (diesel fuel, fuel oil, kerosine, and gasoline).

Petrochemicals.—Louisiana chemical producers in 1963 completed one project, were constructing eight projects, and announced plans for at least five more projects. At Lake Charles, Cities Service Oil Co. completed a $12 million plant to manufacture 35,000 tons of butyl rubber annually but operated it at 75 percent of capacity. The company acquired full ownership of Petroleum Chemicals, Inc., a large producer of ammonia, butadiene, propylene, and ethylene, and announced plans to build a 1-million-pound-per-year cyclic chemical plant. Continental Oil Co. contracted to build a Molex unit to produce chemical intermediates (olefins) for making "soft" detergents. Pittsburg Plate Glass Co. was building a plant to produce trichloroethylene and perchloroethylene; completion was scheduled for 1964.

At Franklin, St. Mary Parish, Cabot Corp. was adding annual capacity of 17 million pounds of thermal black from natural gas. Completion of the $900,000 project was scheduled for the yearend.

At Avondale, Jefferson Parish, American Cyanamid Co. was constructing an addition to its Fortier plant. When completed, the new facility will produce 40 million pounds of methyl methacrylate monomer annually. The monomer, to be manufactured from the company's own hydrocyanic acid, will be converted into plastics and artificial fibers. Plant completion was scheduled into two stages, the first in mid-1964.

At Laplace, St. John the Baptist Parish, E. I. du Pont de Nemours & Co., Inc., started constructing a $20 million plant to produce adiponitrile—a chemical intermediate for making nylon.

In the Baton Rouge area, chemical plant construction was impressive. At Gramercy, Kaiser Aluminum & Chemical Corp. announced plans to build a $4 million plant to manufacture isocyanates—a major constituent of urethane plastics. At Geismar, Naugatuck Chemical Division of U.S. Rubber Co. was constructing a rubber plant and started a new unit to produce hydrazine. Principal raw material for the unit will be ammonia, and the output will be used captively. Also at Geismar, Wyandotte Chemical Co. contracted to construct an $8 million addition to its chlorine-caustic plant.

Allied Chemical Corp. (Union Texas Petroleum Division) postponed action to build a plant to produce both olefins and aromatic chemicals at the Geismar site. Tentative plans were to produce olefins only at Geismar.

At Baton Rouge, Enjay Chemical Co., a division of Humble Oil & Refining Co., announced plans to build a plant to produce 5 million pounds of neo-acids annually. Enjay also was expanding its ethylene capacity to 400 million pounds per year and was constructing a linear olefin plant to be completed in the second quarter of 1964.

At its Baton Rouge refinery, Humble Oil & Refining Co. completed an $8 million coking unit, and Reynolds Metals Co. completed a $2.5 million plant to calcine coke. Reynolds will use the calcined coke to make electrodes for use in aluminum reduction plants.

NONMETALS

Value of nonmetals (chemical and construction materials) produced in 1963 was $130 million, or 5 percent of total minerals value and a gain of 3 percent compared with 1962. Combined value of construction materials (clay, lime, cement, gypsum, sand and gravel, and stone or shell) gained 3 percent.

Alumina.—Kaiser Aluminum & Chemical Corp. produced alumina at its Gramercy and North Baton Rouge plants. The metallurgical alumina from these two plants was then transported downstream to the firm's aluminum works at Chalmette for reduction to primary aluminum.

Barite.—Crude barite, imported from Arkansas, Missouri, and foreign countries, was ground in Louisiana for use as weighting material in oil well drilling fluids. Three grinding plants operated at New Orleans and one at Lake Charles. Output of ground barite was about 9 percent more than in 1962 although footage drilled for oil and gas in the State declined about 5 percent.

Cement.—An 11-percent gain in portland cement production at three plants was attributed mainly to public works construction, as indicated by increased value of construction contracts awarded (table 5). Both residential and nonresidential construction exhibited appreciable gains.

Oklahoma Cement Co. was constructing a 1.5-million-barrel per year capacity plant on the Michoud Canal, New Orleans. About 100 persons will be employed. Jahncke Services, Inc., will supply the plant with oystershell.

Clays.—There was an overall slight gain in miscellaneous clay produced. Clay used for cement gained about 23 percent, but was offset by loss in brick output. Lagging use of brick in construction accounted for the loss. About 124,000 tons of local clay was used to manufacture heavy clay products at nine brick plants in nine parishes. Lightweight aggregate was produced at Alexandria, Rapides Parish, and Erwinville, Point Coupee Parish.

Gypsum.—Winn Rock, Inc., Winn Parish, mined crude gypsum for retarder in portland cement; output was about 20 percent less than in 1962. National Gypsum Co. at Westwego and U.S. Gypsum Co. and Bestwall Gypsum Co. at New Orleans calcined imported crude gypsum and manufactured plaster, lath, and wallboard.

TABLE 19.—Shipments of portland cement to Louisiana consumers

Year	Louisiana (thousand barrels)	Change, percent	
		In Louisiana	In United States
1954–58 (average)	7,554		
1959	8,908	+11	+9
1960	8,007	−10	−7
1961	7,865	−2	+3
1962	8,875	+13	+3
1963	9,112	+3	+5

TABLE 20.—Miscellaneous clay sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954–58 (average)	710	$756	1961	645	$645
1959	904	904	1962	638	641
1960	749	749	1963	655	655

Lime.—Lime production gained slightly. About 65 percent of the total production (calcined and regenerated) was used by chemical plants, 33 percent by paper plants, and 2 percent by the building trade and agriculture. Shell was calcined to lime at one paper plant, two chemical plants, and two lime plants; regenerated lime was produced at six paper plants. Lime producers for the open market were U.S. Gypsum Co. at New Orleans and Pelican State Lime Co. at Morgan City.

Nitrogen Compounds.—Air Reduction Sales Co. operated its air separation plant at the old Ronaldson airport near Baton Rouge. The plant has a daily production capacity of 30 tons of liquid oxygen, nitrogen, and argon for industrial uses. The company announced plans to build an $8 million air separation plant adjacent to the Michoud-Saturn plant at New Orleans.

Salt.—Output of salt gained about 18 percent because of increased consumption of brine and rock salt by chemical plants. Evaporated and/or rock salt were produced by six salt companies; brine was produced by six chemical companies. Markets supplied were principally municipal street deicing, meat packers, chemicals, refrigeration, and animal feed mixers.

TABLE 21.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954–58 (average)	3,452	$16,422	1961	4,722	$23,357
1959	4,807	20,918	1962	5,248	27,407
1960	4,792	21,959	1963	6,199	30,450

Responding to the growing demand for a variety of chemicals from salt, the Ethyl Corp. completed a $1.6 million chlorine-caustic soda plant at Baton Rouge and Wyandotte Chemical Corp. contracted to build an $8 million chlorine-caustic soda plant at Geismar to supply chemicals from salt to the huge petrochemical complex at that site.

Louisiana's tremendous reserves of salt in its many salt domes, both inland and costal, attracted attention of salt producers especially because of favorable orientation of these reserves to water transportation and to markets. At the Cote Blanche Island salt dome in St. Mary Parish, Carey Salt Co. (with Monsanto Chemical Co.) approached completion of shaft-sinking operations. The dome, at a depth of 564 feet, is in Cote Blanche Bay and is bounded on the north by the Intercoastal Canal. Planned rate of production is 300 tons of rock salt per hour.

TABLE 22.—Salt production, by types

(Thousand short tons and thousand dollars)

Type	1960		1961		1962		1963	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Evaporated salt	191	$4,737	196	$4,430	246	$6,298	250	$5,987
Rock salt	1,730	12,097	1,770	12,884	2,004	13,531	2,294	15,228
Brine	2,871	5,125	2,756	6,043	2,998	7,578	3,655	9,235

A salt dome was discovered in Tensas Parish when two exploratory oil wells were drilled in sec 22, T 14 N, R 10 E. Salt was encountered at 5,984 feet in the first well and at 7,090 feet in the second well.

Sand and Gravel.—Production of 12.5 million tons of sand and gravel—about 4 percent more than in 1962—reflected a small gain in demand for building. Washed sand and gravel amounted to 12.0 million tons, or 96 percent of the total. Sand use was as follows: Building sand, 54 percent; paving sand, 43 percent; and other construction and fill sand, 3 percent. Gravel use was as follows: Paving gravel, 47 percent; building gravel, 51 percent; and other construction and fill gravel, 2 percent. There were 73 sand and gravel operations in 27 parishes.

Responding to the growing demand in the New Orleans area for high-purity silica sand to manufacture glass, Jahncke Services, Inc., installed specialized facilities to handle this grade of sand at its plant on the industrial canal (slip No. 4) in the eastern part of New Orleans. These plant facilities, started in 1962, had the following capacities in tons per hour: Silica sand, 25; industrial sand, 30; and crushed shell, 12.

Sand for the new plant came from the same area that had supplied sized commercial sand and gravel to the company's slip No. 4 yard for several years. The company operated two dredges and auxiliary floating processing plants on West Pearl River between Pearl River and Bogalusa, in St. Tammany Parish. Previously, dredging was on the Mississippi side of the river. The river sand deposits vary in fineness, are all very clean, and are worked selectively by the two dredges. When the water level is high, the dredges can operate in landlocked pits dug back from the river; when the water level is low,

TABLE 23.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total sand and gravel	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	11,577	$14,110	262	$114	11,839	$14,224
1959	15,505	19,898	547	213	16,052	20,111
1960	13,935	18,990	384	116	14,319	19,106
1961	11,783	14,729	259	104	12,042	14,833
1962	11,701	14,682	339	135	12,040	14,817
1963	12,125	14,551	375	150	12,500	14,701

TABLE 24.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	2,065	$1,932	2,283	$2,283
Paving	1,802	1,680	1,821	1,730
Other [1]	117	93	129	73
Total	3,984	3,705	4,233	4,086
Gravel:				
Building	3,382	4,749	3,973	5,435
Paving	4,163	6,028	3,760	4,869
Fill	(2)	(2)	82	59
Other [3]	172	200	77	102
Total	7,717	10,977	7,892	10,465
Total sand and gravel	11,701	14,682	12,125	14,551
Government-and-contractor operations:				
Gravel:				
Building	245	98	240	96
Paving	94	37	135	54
Total sand and gravel	339	135	375	150
Grand total	12,040	14,817	12,500	14,701

[1] Includes fill, filtration, blast, and other construction.
[2] Included in "Other" commercial gravel.
[3] Includes railroad ballast, fill (1962), other construction, and miscellaneous gravel.

they are confined to the river bed. Sand from the dredges was barged about 50 miles via the river, the Intracoastal Canal, and the Inner Harbor Navigation Canal.

TABLE 25.—Sand and gravel production in 1963, by parishes

Parish	Short tons	Value	Parish	Short tons	Value
Beauregard	38,729	$63,354	Tangipahoa	1,606,192	1,291,215
Bossier	75,000	30,000	Vermilion	2,140	2,675
Catahoula	429,750	625,050	Vernon	1,350	540
East Baton Rouge	1,092,235	1,013,328	Washington	971,149	628,770
Lincoln	240,319	96,127	Webster	867,440	1,254,458
Livingston	142,008	272,195	Other parishes [1]	6,821,483	9,309,328
Morehouse	49,671	19,868	Total	12,500,000	14,701,000
Natchitoches	2,025	810			
Red River	160,509	93,282			

[1] Includes Allen, Caddo, East Feliciana, Evangeline, Grant, Jefferson Davis, LaSalle, Madison, Ouachita, Rapides, St. Helena, St. Tammany, and West Feliciana, and undistributed amounts from various parishes, combined to avoid disclosing individual company confidential data.

Stone.—Most of the stone produced was shell (clam and oyster). A small amount of miscellaneous stone was produced in Winn Parish for road surfacing and concrete. Lacking an adequate supply of stone, Louisiana relied on shell as a substitute. Shell used for concrete aggregate and road construction was 71 percent; as cement raw material, 23 percent; burned to lime, 5 percent; and as paint filler, rubber filler, and mineral food, 1 percent. Total output of shell declined 5 percent from 1962.

Winn Rock, Inc., at Winnfield, operated an asphalt-filler plant; silica sand was purchased for use as base material.

Sulfur.—Shipments of Frasch sulfur were at a record level, exceeding the 1962 total by 8 percent. Reductions in delivered price of sulfur, particularly in foreign markets, caused a 2 percent decline in overall value. Sulfur was recovered at refining operations in Lake Charles and Baton Rouge.

Freeport Sulphur Co. was the world's largest producer of sulfur in 1963, producing about the same amount as was sold. Production came almost entirely from its Frasch-process mines at Grande Ecaille, Garden Island Bay, Lake Pelto in southeast Louisiana, and Grand Isle off the Louisiana coast.

In the United States, the company's largest single market continued to be the Tampa, Fla., area where sulfur converted to sulfuric acid was used to process phosphate rock into fertilizer materials. The consumption pattern in the Nation remained unchanged—about 58 percent going to the fertilizer industry and the remainder to makers of chemicals, pigments, paper, steel, petroleum products, and a wide variety of other goods. Exports of United States sulfur and imports of Mexican and Canadian sulfur increased in 1963.

TABLE 26.—Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments		Year	Productions	Shipments	
		Quantity	Value			Quantity	Value
1954–58 (average)	2,140	2,070	$53,384	1961	2,608	2,352	$55,164
1959	2,035	2,252	52,779	1962	2,363	2,262	49,772
1960	2,264	2,256	52,639	1963	2,469	2,445	48,905

As 90 percent of Freeport's domestic shipments of sulfur was delivered in the preferred liquid form, the company was increasing liquid storage facilities at Port Sulphur by approximately 50 percent. A third 10,000-ton liquid sulfur barge tow was put into service on inland waterways and, in 1964, transatlantic deliveries of liquid sulfur will be initiated by Sulphur Export Corp. (Sulexco). Two large vessels will deliver Louisiana and Texas sulfur to a terminal under construction at Rotterdam, Holland. Sulexco cancelled plans to build a sulfur terminal at Immingham, England.

Freeport Sulphur Co.'s central Research & Development Laboratory at Belle Chase completed its first year of activity. Research was directed to market-control (manufacture of sulfuric acid, additives to facilitate handling of solidified sulfur, and detection of impurities in liquid sulfur) and production-control problems.

METALS

Aluminum.—Kaiser Aluminum & Chemical Corp. operated its aluminum reduction plant at Chalmette. Following entry into the chemical field, Kaiser announced construction of a $4 million plant at its Gramercy Works to produce isocyanates, a major constituent of ure-

thane plastics. The company also produced fluorochemicals at Gramercy.

Iron Ore.—The Louisiana Geological Survey investigated iron ore deposits in Claiborne and surrounding parishes. The deposits, identified as siderite and limonite, are bedded deposits exposed in hillsides and are reported to be similar to deposits in East Texas. The report of the investigation, to be completed in 1964, will contain a map of the deposits and estimates of reserves of each type of ore.

REVIEW BY PARISHES

Minerals were produced in all but 1 of the State's 64 parishes. Mineral fuels were produced in 57 parishes; other minerals in 42 parishes. Eight parishes reporting mineral production valued at over $100 million (eight in 1962) were: Plaquemines, $525 million; Terrebonne, $312 million; Lafourche, $295 million; St. Mary, $179 million; Cameron, $155 million; Vermilion, $145 million; Acadia, $112 million; and Jefferson, $108 million. Three parishes reporting between $100 million and $50 million (four in 1962) were: Iberia, $92 million; St. Martin, $62 million; and Jefferson Davis, $53 million. Forty-one other parishes reported mineral production valued at over $1 million. Only those parishes with significant mineral production and mineral industry activity are discussed in this review; see table 27 for additional details.

Acadia.—Exploratory drilling of 17 wells for petroleum and natural gas proved 1 discovery which opened the Lawson gasfield; 26 of the 49 development wells drilled were productive. About 89 crew-weeks were spent in geophysical prospecting. The parish ranked first in recovering natural gas liquids valued at $31.4 million. Six plants recovered the liquids and the Church Point plant of Pan American Petroleum Corp. was shut down.

Ascension.—At Geismar, Naugatuck Chemical Division of U.S. Rubber Co. was constructing a rubber plant and started a new unit to produce hydrazine. Principal raw material for the unit will be ammonia; output will be used captively. Also at Geismar, Wyandotte Chemical Co. contracted to construct an $8 million addition to its chlorine-caustic plant.

Allied Chemical Corp. (Union Texas Petroleum Division) postponed action to build a plant to produce both olefins and aromatic chemicals at the Geismar site. Tenative plans were to produce olefins only at Geismar.

TABLE 27.—Value of mineral production in Louisiana, by parishes [1]

Parish	1962 [2]	1963 [3]	Minerals produced in 1963 in order of value
Acadia	$97,758,691	$111,726,257	Natural gas, petroleum, natural gas liquids.
Allen	8,676,482	11,401,896	Petroleum, natural gas, sand and gravel, natural gas liquids.
Ascension	2,558,962	2,791,586	Petroleum, natural gas, salt.
Assumption	21,244,887	21,163,281	Natural gas, petroleum.
Avoyelles	1,714,845	2,139,374	Petroleum, natural gas liquids, natural gas.
Beauregard	14,013,861	10,193,204	Petroleum, natural gas, natural gas liquids, sand and gravel.

See footnotes at end of table.

TABLE 27.—Value of mineral production in Louisiana, by parishes[1]—Continued

Parish	1962 [2]	1963 [3]	Minerals produced in 1963; in order of value
Bienville	$9,171,571	10,231,022	Natural gas, petroleum.
Bossier	47,773,340	46,792,647	Natural gas, petroleum, natural gas liquids, sand and gravel.
Caddo	30,943,338	$34,281,828	Petroleum, natural gas, natural gas liquids, sand and gravel, clays.
Calcasieu	40,263,487	41,963,951	Petroleum, natural gas, cement, natural gas liquids, lime, salt, clays.
Caldwell	1,704,746	2,226,927	Natural gas, petroleum.
Cameron	132,169,872	154,550,154	Natural gas, petroleum, natural gas liquids, shell, salt.
Catahoula	7,888,049	9,526,960	Petroleum, sand and gravel, natural gas.
Claiborne	24,640,061	24,731,097	Petroleum, natural gas, natural gas liquids.
Concordia	12,655,613	14,854,708	Do.
De Soto	11,901,307	11,740,300	Natural gas, petroleum, natural gas liquids.
East Baton Rouge	14,706,788	16,116,429	Cement, lime, petroleum, sand and gravel, natural gas, natural gas liquids, clays.
East Feliciana	[4]	[4]	Sand and gravel.
Evangeline	10,317,425	9,858,985	Petroleum, natural gas, natural gas liquids, sand and gravel.
Franklin	2,764,139	2,542,855	Petroleum, natural gas.
Grant	[4]	[4]	Petroleum, sand and gravel.
Iberia	94,732,936	91,791,480	Petroleum, natural gas, salt, natural gas liquids, clays.
Iberville	30,698,267	34,415,302	Petroleum, natural gas, salt.
Jackson	83,650	100,731	Natural gas, petroleum.
Jefferson	94,541,057	108,222,004	Petroleum, natural gas, sulfur, natural gas liquids, shell.
Jefferson Davis	47,538,207	52,923,365	Natural gas, petroleum, natural gas liquids, sand and gravel.
Lafayette	14,088,429	14,109,136	Petroleum, natural gas, clays.
Lafourche	260,353,823	294,526,607	Petroleum, natural gas, natural gas liquids.
La Salle	17,808,614	18,360,885	Petroleum, natural gas, sand and gravel.
Lincoln	18,104,334	26,107,507	Natural gas, natural gas liquids, petroleum, sand and gravel, clays.
Livingston	357,950	548,011	Sand and gravel, petroleum, natural gas.
Madison	1,631,083	1,443,833	Petroleum, sand and gravel, natural gas.
Morehouse	1,890,336	1,853,774	Natural gas, sand and gravel, petroleum.
Natchitoches	259,236	207,673	Petroleum, clays, natural gas, sand and gravel.
Orleans	[4]	[4]	Cement, lime, shell.
Ouachita	7,351,310	9,636,788	Natural gas, petroleum, sand and gravel, natural gas liquids, clays.
Plaquemines	471,619,819	524,705,328	Petroleum, natural gas, sulfur, natural gas liquids.
Pointe Coupee	6,952,039	7,451,119	Petroleum, natural gas, natural gas liquids, clays.
Rapides	1,486,521	2,313,703	Petroleum, sand and gravel, clays, natural gas.
Red River	974,505	883,877	Petroleum, sand and gravel, natural gas.
Richland	15,760,417	15,622,704	Petroleum, natural gas, natural gas liquids.
Sabine	7,213,054	12,828,659	Petroleum, natural gas.
St. Bernard	9,355,481	12,575,139	Natural gas liquids, petroleum, natural gas, shell.
St. Charles	40,175,620	42,422,102	Petroleum, natural gas, natural gas liquids.
St. Helena	[4]	[4]	Sand and gravel.
St. James	3,906,105	4,524,794	Petroleum, natural gas, natural gas liquids.
St. John the Baptist	3,714,826	3,748,879	Petroleum, natural gas.
St. Landry	55,448,509	45,423,472	Petroleum, natural gas, natural gas liquids.
St. Martin	57,426,049	62,233,929	Petroleum, natural gas, salt, natural gas liquids.
St. Mary	164,149,016	178,723,499	Petroleum, natural gas, shell, natural gas liquids, salt, lime.
St. Tammany	2,197,640	2,386,619	Shell, sand and gravel, natural gas, clays, petroleum.
Tangipahoa	469,587	1,394,919	Sand and gravel, petroleum, clays, natural gas.
Tensas	15,577,220	19,043,727	Petroleum, natural gas, natural gas liquids.
Terrebonne	282,253,071	312,060,898	Petroleum, natural gas, sulfur, natural gas liquids.
Union	13,564,376	15,946,792	Natural gas, petroleum.
Vermilion	132,143,583	145,156,436	Natural gas, petroleum, natural gas liquids, sand and gravel.
Vernon	4,998	540	Sand and gravel.
Washington	[4]	[4]	Sand and gravel, lime.
Webster	30,265,858	31,816,409	Natural gas, petroleum, natural gas liquids, sand and gravel.
West Baton Rouge	1,187,900	1,114,254	Petroleum, natural gas, clays.
West Carroll	318,808	316,768	Natural gas.
West Feliciana	105,948	[4]	Sand and gravel.
Winn	4,986,006	4,420,031	Petroleum, salt, stone, gypsum, natural gas.
Undistributed	23,059,348	21,865,846	
Total	2,426,623,000	2,662,061,000	

[1] East Carroll not listed because no production was reported.
[2] Revised figures.
[3] Preliminary figures.
[4] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Avoyelles.—Exploratory drilling of 54 wells resulted in completion of 11 oil wells which opened 9 oilfields. Natural gas liquids were recovered at the Eola plant of Anchor Gasoline Corp.

Beauregard.—Exploratory drilling of seven wells in the parish proved one oil well productive. Natural gas liquids were recovered at three plants.

Bossier.—Natural gas liquids were recovered at five gas processing plants. Exploratory drilling of 10 wells resulted in 4 productive oil wells.

Caddo.—The parish ranked first in total number of oil and gas wells drilled—825 wells in 1963 (500 in 1962). Most of the drilling was in development wells in the Pine Island area. Natural gas liquids were recovered at four gas processing plants.

Caddo Light Aggregate Co., Inc., a subsidiary of Bayou State Oil Corp., did not operate its lightweight aggregate plant northwest of Shreveport.

At Shreveport, Universal Oil Products Co. manufactured special catalysts for petroleum refinery processes.

Calcasieu.—Lake Charles Industrial Complex, comprising over a dozen large plants built to facilitate production and processing of crude petroleum, natural gas, natural gas liquids, cement, sulfur, lime, and salt, was one of the most important in the State.

At Lake Charles, Cities Service Oil Co. completed a $12 million plant to manufacture 35,000 tons of butyl rubber annually. The company acquired full ownership of Petroleum Chemicals, Inc., a major producer of ammonia, butadiene, propylene, and ethylene, and announced plans to build a plant to produce 1 million pounds annually of cyclic chemicals. Continental Oil Co. contracted to build a Molex unit to produce chemical intermediates (olefins) for making "soft" detergents. Pittsburgh Plate Glass Co. was building a plant to produce trichloroethylene and perchloroethylene; completion was scheduled for 1964.

Olin Mathieson Chemical Corp. was constructing additional plant facilities to produce chlorine and caustic soda.

Exploratory drilling of 23 wells proved 2 gas wells and 1 oil well which opened the Beckwith Creek oilfield.

The Calcasieu River and Pass, the State's second waterway capable of accommodating seagoing traffic, was dredged for a deeper and wider channel to permit passage of larger tankers to the port of Lake Charles; the existing channel dimensions were to be extended 2.2 miles upstream to permit seagoing ships to reach the ore-grinding facilities of Lake Charles Harbor. Other new port facilities to be constructed at Lake Charles included a canal 6 miles long for an industrial waterfront and a $1.8 million bulk handling plant capable of berthing ships for exporting petroleum coke in 10,000-ton cargoes.

Cameron.—The parish ranked fifth in total value of mineral production and second in value of natural gas. Exploratory drilling of 31 wells offshore proved 4 gas wells; exploratory drilling of 25 wells onshore proved 1 oil well, 5 gas wells, and opened North Deeplake, Price Lake, and Southwest Lake Arthur gasfields.

Natural gas liquids were recovered at 11 gas-processing plants, including the new Grand Chenier plant of Continental Oil Co.

Catahoula.—Drilling of 82 exploratory wells resulted in 3 productive oil wells and opening of Stokes Creek oilfield; development drilling resulted in 38 oil wells and 75 dry holes.

Claiborne.—Natural gas liquids were recovered at three gas processing plants. Exploratory and development drilling of 23 wells resulted in 7 oil wells, 8 gas wells, and discovery of North Homer gasfield.

The Louisiana Geological Survey investigated iron ore deposits in Claiborne and surrounding parishes. The deposits, identified as siderite and limonite, are bedded deposits exposed in hillsides and are reportedly similar to deposits in East Texas. The report of the investigation, to be completed in 1964, will contain a map of the deposits and estimated reserves of each type of ore.

Concordia.—Drilling of 88 exploratory wells resulted in 8 productive oil wells and opening of South Rifle Point, Catfish Bayou, and Shaw oilfields. Development drilling of 84 wells proved 41 oil wells.

De Soto.—Drilling of 66 wells (111 in 1962) proved 16 oil wells and 19 gas wells.

South Louisiana Production Co. operated its underground gas storage system in the Holley field reservoir. Working capacity of the storage is 1 billion cubic feet. Another gas storage project was planned for the old Grand Cane field.

East Baton Rouge.—Construction of new facilities and expansion of existing facilities were reported in the Baton Rouge area.

Enjay Chemical Co., a division of Humble Oil & Refining Co., announced plans to build a plant to produce 5 million pounds of neoacids annually. Enjay also was expanding its ethylene capacity to 400 million pounds per year and was constructing a linear olefin plant to be completed in the second quarter of 1964. At its Baton Rouge refinery, Humble Oil & Refining Co. completed an $8 million coking unit, and Reynolds Metals Co., a $2.5 million plant to calcine the coke. Reynolds will use the calcined coke to make electrodes for use in aluminum reduction plants. Ethyl Corp., a principal producer of motor fuel additives, completed a $1.6 million plant to produce chlorine and caustic soda. Polymer Chemical Division, W. R. Grace & Co., produced polyethylene plastics. Copolymer Rubber & Chemical Corp. produced butadiene for conversion to styrene-butyl rubber.

Natural gas liquids were recovered at the Burtville plant of Shell Oil Co. Clay was mined by Acme Brick Co. to manufacture brick. Ideal Cement Co. produced portland cement, high-early-strength, and masonry cements from shell which was barged up the Mississippi River by a New Orleans supplier. Kaiser Aluminum & Chemical Corp. processed Jamaican bauxite into alumina at its North Baton Rouge plant.

Evangeline.—Natural gas liquids were recovered at Ville Platte plant of Continental Oil Co., and at Mamou and Pine Prairie plants of Socony Mobil Oil Co. Exploratory drilling of six wells proved one gas well which opened Beacons Gully gasfield.

Iberia.—The parish ranked first in salt production; about 35 percent of the State's output came from three large mines. Natural gas liquids were recovered at four plants. Drilling of 7 exploratory wells proved all dry; drilling of 32 field wells proved 17 oil wells and 9

gas wells productive. Two gasfields and one oilfield were discovered offshore in South Marsh Island area (Blocks 66 and 79, gas; Block 6, oil).

Iberville.—Gulf States Utilities Co. completed a $19.6 million expansion of its Sunshine plant to add 220,000-kilowatts of generator capacity. Drilling of 12 exploratory wells proved 1 gas well which opened the South Klondike gasfield; drilling of 58 development wells proved 47 oil wells and 2 gas wells.

Jefferson.—Freeport Sulphur Co. produced sulfur at its Grand Isle offshore platform.

The parish ranked fifth in petroleum output, which was valued at $86 million. Natural gas liquids were recovered at one gas processing plant. West Pontchartrain E. Block 41 and Bassa Bassa Bay gasfields were discovered onshore; West Delta Block 117 oilfield was discovered offshore.

At Avondale in Jefferson Parish, American Cyanamid Co. was constructing an addition to its Fortier plant. When completed in 1964, the new facility will produce 40 million pounds of methyl methacrylate monomer annually. The monomer, to be manufactured from the company's own hydrocyanic acid, will be converted into plastics and artificial fibers. Plant completion was scheduled in two stages, the first in mid-1964.

Jefferson Davis.—Exploratory drilling of 14 wells proved 1 oil well and 2 gas wells which opened the East Lake Arthur and Hathaway gasfields. Natural gas liquids were recovered by four gas processing plants.

Lafourche.—The parish ranked third in total value of minerals produced, second in crude oil produced, and fifth in natural gas output. Extensive exploration for petroleum (135 crew-weeks) and drilling of 42 exploratory wells resulted in 9 productive wells but no new fields. Natural gas liquids were recovered at three gas processing plants.

Lincoln.—The parish, with three gas processing plants, recovered natural gas liquids valued at $12 million. Ruston Brick Works mined clay at Ruston.

Orleans.—Most of the barite ground in the State was from foreign ores and was processed in Orleans Parish by three companies. Alatex Construction Services, Inc., processed crude perlite from Western States into expanded perlite for use in acoustical plasters and concrete aggregate.

At New Orleans, U.S. Gypsum Co. manufactured building lime, quicklime, and hydrated lime at its lime plant adjacent to the company's gypsum products plant and fronting on the Inner Harbor Industrial Canal. Bestwall Gypsum Co. operated its gypsum lath and plaster products plant near New Orleans.

Oklahoma Cement Co. was building a $12 million plant, located on the Michoud Canal and designed to manufacture 1.5 million barrels of cement annually.

To meet demand in the New Orleans area for high-purity silica sand to manufacture glass, Jahncke Services, Inc., installed specialized facilities to handle this grade of sand at its plant on the industrial canal (slip No. 4) in the eastern part of New Orleans. The plant facilities,

started in 1962, had the following capacities in tons per hour: Silica sand, 25; industrial sand, 30; and crushed shell, 12.

The Barataria waterway project was completed to promote industrial growth in the Baton Rouge-New Orleans area. The waterway extends from the Intracoastal Waterway near New Orleans to the Gulf of Mexico at Grand Isle. Construction of the $1.6 million project began in 1960.

The huge Michoud plant of the National Aeronautics & Space Administration which manufactures booster engines for the Saturn space vehicle received substantial additional appropriations for production facilities.

Ouachita.—Acme Brick Co. mined clay at Monroe to manufacture brick and tile. Natural gas liquids were recovered at the Calhoun plant of Arkansas Louisiana Chemical Corp. Drilling of 82 development wells proved 73 gas wells; drilling of 4 exploratory wells proved 2 other gas wells, but no fields were discovered.

Olin Mathieson Chemical Corp. was making substantial additions to its pulp and paper plant at West Monroe.

Plaquemines.—Total value of mineral production in the parish—situated in the Mississippi River delta—increased from $471.6 million (revised) in 1962 to $524.7 million in 1963—highest in the State. The parish ranked first in production of crude petroleum and sulfur and fourth in natural gas. Geophysical prospecting amounted to 80 crew-weeks. The parish ranked third in total number of oil and gas wells drilled—315 wells in 1963 (290 in 1962). West Delta Block 73 oilfield and West Delta Block 64, Breton Sound Block 18, and Main Pass Block 129 gasfields were discovered offshore. The parish had vast onshore and offshore reserves of petroleum and natural gas.

Natural gas liquids were recovered at five gas processing plants.

Freeport Sulphur Co.'s Central Research & Development Laboratory at Belle Chase completed its first year of activity. The company was developing further its facilities for handling molten sulfur at Port Sulphur.

Rapides.—Two commercial producers and one Government-and-contractor sand and gravel producer operated in the parish during 1963. Clay was mined for producing lightweight aggregate by Louisiana Lightweight Aggregate Co. and for structural clay products by Acme Brick Co. Exploratory drilling of 21 wells proved 1 oil well; development drilling of 57 wells proved 25 oil wells.

Sabine.—The parish ranked second in total wells drilled during the year. Of 21 exploratory wells drilled, 8 oil wells and 1 gas well were productive; of 761 field development wells drilled, 465 oil wells and 2 gas wells were productive.

Survey work was completed on the Toledo Bend Dam on the Sabine River and contracts were submitted for construction and for installation of hydroelectric facilities. Completion of the $60 million project is scheduled for 1966.

St. Bernard.—Natural gas liquids were recovered at three plants including the Shell Oil Co. new Ysclosky gas processing plant on the new Mississippi River-Gulf Outlet Channel. Drilling of 29 exploratory wells proved 3 oil wells and 3 gas wells which opened Half Moon Lake oilfield and Bayou Biloxi gasfield.

Tenneco Oil Co. operated its 48,000-barrel-per-day refinery at Chalmette, and Murphy Corp. operated its 22,000-barrel-per-day refinery at Meraux.

Kaiser Aluminum & Chemical Corp. operated its Chalmette aluminum works all year.

St. James.—At Gramercy, Kaiser Aluminum & Chemical Corp. completed a $1.4 million plant to produce aluminum fluoride, and also announced construction of a $4 million plant to produce isocyanates, a major constituent of urethane plastics.

St. John the Baptist.—Louisiana Power & Light Co. started constructing a second computer-controlled generating unit at its Little Gypsy steam-generating station near Laplace on the Mississippi River. This second unit, which will cost about $26 million and have a capacity of 400,000 kilowatts, is scheduled for completion at the end of 1965. Gas fuel will be used for steam generation at the two new plants.

Also at Laplace, E. I. du Pont de Nemours & Co., Inc., started constructing a $20 million plant to produce adiponitrile—a chemical intermediate for making nylon.

St. Landry.—Natural gas liquids were recovered at five gas processing plants. Drilling of 47 development wells proved 21 oil wells and 8 gas wells; drilling of 14 exploratory wells proved 2 gas wells but no fields were discovered.

St. Mary.—The parish ranked fourth in total value of minerals and in petroleum production and also produced appreciable quantities of natural gas, natural gas liquids, and shell.

Geophysical prospecting totaled 85 crew-weeks during the year. However, drilling of 20 exploratory wells proved all dry.

A new salt mine was under development by Carey Salt Co. at Cote Blanche salt dome. The dome, at a depth of 564 feet, is in Cote Blanche Bay and bounded on the north by the Intracoastal Canal.

At Franklin, the Cabot Corp. was adding a facility with an annual capacity of 17 million pounds of thermal black from natural gas. Completion of the $900,000 project was scheduled for yearend.

Natural gas liquids were recovered at five plants.

A combine of 29 oil companies will build Louisiana's largest gas processing plant at Gibson and send the recovered liquids by pipeline to a fractionating plant planned at Geismar.

Freeport Sulphur Co. mined sulfur by the Frasch process from its Lake Pelto mine opened in 1960.

Tensas.—Drilling of 20 exploratory wells proved 4 oil wells and opened Mound Bayou oilfield. Drilling of 57 other field development wells proved 32 oil wells and 2 gas wells.

A salt dome was discovered in the parish when two exploratory oil wells were drilled in sec 22, T 14 N, R 10 E. Salt was encountered at 5,984 feet in the first well and at 7,090 feet in the second well.

Natural gas liquids were recovered by three gas processing plants.

Terrebonne.—The parish ranked second in total value of minerals produced, first in natural gas production, third in oil production, and fourth in number of wells drilled for exploration and development of petroleum and natural gas. Exploratory drilling resulted in offshore discoveries of South Timbalier Block 219 gasfield and South Timbalier Block 176 oilfield.

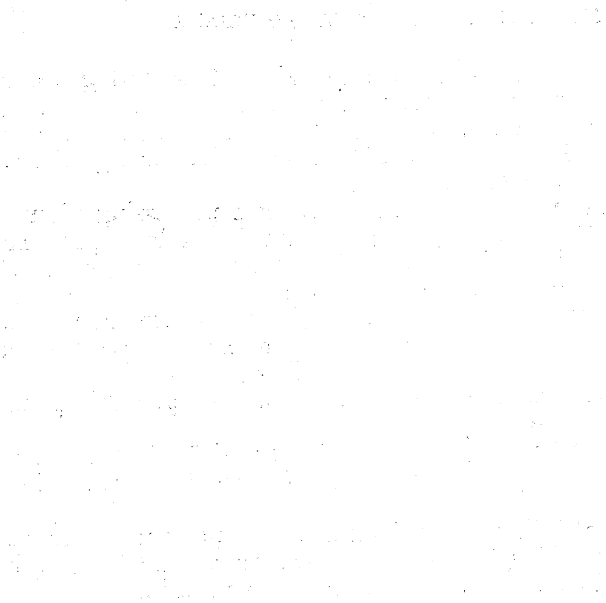
Vermilion.—The parish ranked third in value of natural gas and second in value of natural gas liquids produced. Exploratory drilling of 29 wells offshore proved 1 oil well and 8 gas wells and resulted in discovery of Vermilion Block 162 and Vermilion Block 250 gasfields. Andrew gasfield was discovered onshore.

Natural gas liquids were recovered at five gas processing plants. One of these plants (Cow Island) supplied mixed liquids by pipeline to the Goliad Corp. Riverside fractionator at Geismar on the Mississippi River. At Geismar, the hydrocarbon components from the fractionator were supplied as feedstock to the petrochemical plants.

Webster.—The parish ranked fifth in value of natural gas liquids recovered by five gas processing plants. Drilling of six exploratory wells proved two gas wells. Lime was produced at the Springhill plant of International Paper Co. for plant use.

Winn.—Drilling of 84 wells (182 in 1962) proved 21 field-development oil wells and no exploratory wells. No new fields were discovered.

Winn Rock, Inc., at Winnfield, mined about 20 percent less crude gypsum than in 1962. The firm also operated an asphalt-filler rock plant, but used purchased silica sand for the base material.



The Mineral Industry of Maine

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Maine, for collecting information on all minerals except fuels.

By Joseph Krickich [1]

MAINE mineral production totaled $14.1 million, 6 percent below that of 1962. Although output of sand and gravel reached a record high, it was insufficient to overcome decreased demand for portland cement and dimension and crushed stone. In addition demand for most of the State's other commodities also declined. In contrast to 1962, no mica or beryl production was reported. Knox County continued as the leading mineral-producing area, followed by Cumberland, York, and Hancock Counties.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Legislative and Government Programs.—Because the Federal Government's program of purchasing strategic minerals ended on June 7, 1962, no mica or beryllium concentrates were produced in Maine in 1963. Final sales of these two commodities to the General Services Administration were limited to the first 6 months of 1962.

TABLE 1.—Mineral production in Maine [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	48	$63	42	$55
Gem stones	(2)	25	(2)	25
Mica:				
Scrap—short tons	15	(3)	----	----
Sheet—pounds	2,017	16	----	----
Peat—short tons	[4] 1,250	47	(5)	(5)
Sand and gravel—thousand short tons	10,014	4,013	11,195	4,673
Stone—do	1,127	4,249	947	3,581
Value of items that cannot be disclosed: Beryllium concentrates (1962), cement, feldspar, and values indicated by footnote 5	----	6,534	----	5,770
Total	----	14,947	----	14,104

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Less than $500.
[4] Revised figure.
[5] Figure withheld to avoid disclosing individual company confidential data.

[1] Mineral specialist, Bureau of Mines, Pittsburgh, Pa.

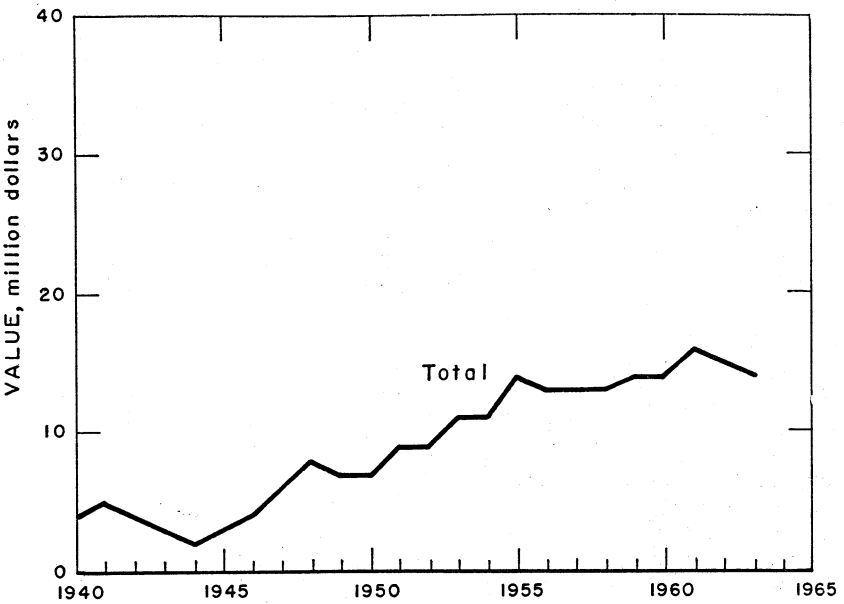


FIGURE 1.—Total value of mineral production in Maine, 1940–63.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$9,949	1958	$12,681
1953	10,986	1959	13,432
1954	11,183	1960	14,002
1955	13,414	1961	15,637
1956	12,492	1962	15,041
1957	12,917	1963	14,167

Water.—The Bureau of Mines in 1963 canvassed the mineral industries to obtain water usage data of the mineral industry in 1962. The data will be analyzed for determining future needs of the industry and for planning water developments. The greatest user of water in Maine was the sand and gravel industry, which used water to wash clay and other contaminants from the crude material. In the stone industry, water was used chiefly for sawing, grinding, and polishing dimension stone and washing crushed aggregates. Most of the water used is returned to the water system, the only consumption being that contained in the product and that evaporated. After usage, 85 percent of the water was returned to surface flow and 15 percent to the ground. A small fraction of the water was discharged into sewers.

TABLE 3.—Water use by the mineral industry in 1962

(Million gallons)

Type of operation	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	8		8	8	(2)	(1)
Nonmetal mines and mills	(2)		(2)	(2)		(1)
Sand and gravel plants	198	13	211	187	11	49.28
Total	206	13	219	195	11	24.64

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Less than 1 million gallon.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Production and shipments of portland cement decreased; masonry cement production and shipments increased slightly. Dragon Cement Co., Division of Martin Marietta Corp., was the only cement producer in Maine. Average value per barrel of portland cement decreased. Yearend stocks were below those of 1962. Dragon Cement Co. produced Type I–II (general use) and Type III (high-early-strength) portland cement. Raw materials used at the plant were cement rock, sand, gypsum, and iron ore, as well as air-entraining compounds and grinding aids. Portland and masonry cement shipments were made mostly to consumers in the New England States. The portland cement was shipped chiefly by truck, in both bulk and paper bags, although substantial quantities were shipped by rail. Principal consumers of portland cement, in order of size, were ready-mixed concrete companies, building material dealers, concrete products manufacturers, and highway and other contractors.

Clays.—Clay production was 12 percent less than in 1962. Most of the output was miscellaneous clay used for manufacturing brick; a limited quantity of fire clay used in manufacturing pottery was produced. Seven clay pits were active, compared with eight in 1962. Production was reported from two pits in Androscoggin County, three in Cumberland, and one each in Hancock and York. Cumberland County continued to lead in clay production.

Feldspar.—Reversing an 8-year downward trend, production and value of feldspar increased slightly. Production was limited to three principal mines in Oxford County. Average unit value for crude material remained at $6.00. All production was crushed at West Paris, Oxford County, by Bell Minerals Co. Processed crude ore from Oxford County and from New Hampshire was used principally in ceramic applications. Shipments of ground feldspar were chiefly to consumers in Pennsylvania and Wisconsin; limited quantities were shipped to seven other States and some was exported to Canada.

Gem Stones.—Value of gem and mineral specimens recovered by amateur collectors remained the same as in 1962. Old mines and dumps in Oxford County continued to attract the greatest mineralogical interest. Minerals collected included amblygonite, autonite, agate, bertrandite, beryl, herderite crystals, rose and smoky quartz, and tourmaline.

Lime.—Quicklime for manufacturing paper was used by Oxford Paper Co. at Rumford, Oxford County. The company regenerated and reused its lime and purchased lime from outside sources only to make up losses. Fuel oil was used at the company's rotary kiln.

Nitrogen Compounds.—Anhydrous ammonia, used as a fertilizer component, was produced by Northern Chemical Industries, Searsport, Waldo County.

Peat.—Peat production was below that of 1962. Output from Washington County was used chiefly as a soil conditioner. No production was reported from Hancock County in 1963.

Sand and Gravel.—For the second consecutive year, sand and gravel production set a new record, rising to 11.2 million tons, which was 12

TABLE 4.—Sand and gravel sold by producers, by classes of operations and uses

Class of operation and use	1962		1963	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Structural	230,128	$152,544	324,687	$235,927
Paving	301,191	242,059	231,037	173,195
Fill	168,772	80,979	175,244	72,049
Other [1]	97,605	73,138	68,897	46,043
Total	797,696	548,720	799,865	527,214
Gravel:				
Structural	131,315	143,088	181,427	170,966
Paving	600,481	441,720	655,527	596,353
Railroad ballast	(2)	(2)	39,792	28,700
Fill	206,722	71,659	209,399	89,628
Other	123,103	64,402	113,397	50,483
Total	1,061,621	720,869	1,199,542	936,130
Total sand and gravel	1,859,317	1,269,589	1,999,407	1,463,344
Government-and-contractor operations:				
Sand:				
Paving	1,673,224	559,326	1,746,287	611,928
Fill	13,076	4,577	(3)	(3)
Other			6,615	2,600
Total	1,686,300	563,903	1,752,902	614,528
Gravel:				
Structural			750	263
Paving	6,467,885	2,179,845	7,432,870	2,591,719
Other			[4] 9,120	[4] 3,450
Total	6,467,885	2,179,845	7,442,740	2,595,432
Total sand and gravel	8,154,185	2,743,748	9,195,642	3,209,960
All operations:				
Sand	2,483,996	1,112,623	2,552,767	1,141,742
Gravel	7,529,506	2,900,714	8,642,282	3,531,562
Total	10,013,502	4,013,337	11,195,049	4,673,304

[1] Includes molding (1962), engine, filtration (1963), and other sand.
[2] Figure withheld to avoid disclosing individual company data: included with other gravel.
[3] Figure withheld to avoid disclosing individual company data; included with other sand.
[4] Includes fill gravel.

percent greater than in 1962. The primary factor in the increased output was the continued expansion of work on highway and road maintenance. Increased production and value was recorded for both commercial and Government-and-contractor operations. The average unit value for commercial tonnage was $0.73, compared with $0.68 in 1962. Paving material accounted for 90 percent of the total production. Eighty-two percent of the output was by Government-and-contractor operations; the Maine State Highway Commission was the State's leading producer. Washed, screened, or otherwise prepared material comprised 57 percent of the commercial sand and gravel, compared with 58 percent in 1962; it was 93 percent of the Government-and-contractor output, compared with 96 percent in 1962. Most shipments to consumers were by truck. Commercial production centered, in decreasing order, in Cumberland, Penobscot, Androscoggin, and York Counties. These counties accounted for 69 percent of the total commercial production. Output by Government-and-contractor operations was chiefly in Kennebec, Penobscot, and Aroostook Counties.

Stone.—Production and value of stone decreased 16 percent, compared with those of 1962. The decline was attributed primarily to decreased production of dimension granite and crushed limestone. A slight increase in production and value was reported for miscellaneous stone. Production of dimension slate increased, but value declined slightly. In terms of value, granite continued to be the leading stone produced. Dimension granite decreased 26 percent in tonnage but continued to lead in value. Output included rough and dressed construction, monumental, and architectural stone, as well as rubble, curbing, and flagging. Slate, the only other dimension stone produced, was marketed as electrical slate and flagging. Crushed and broken stone, including granite, limestone, and miscellaneous stone, was used primarily for concrete aggregate and roadstone. Output reported for this use totaled 318,000 tons, compared with 351,000 tons in 1962. Dimension granite was produced in Hancock, Knox, and York Counties; crushed granite was produced in Cumberland County. Knox County continued as the leading limestone-producing area, followed by Aroostook, Kennebec, and Somerset Counties. Slate was produced exclusively in Piscataquis County. Crushed miscellaneous stone was produced in Cumberland County. Limited quantities of quartz, used exclusively for exposed aggregate, were recovered in Oxford County.

METALS

Blackhawk Mining Ltd., continued its diamond-drilling program on a copper-zinc prospect near Blue Hill in Hancock County. The company planned to sink a shaft in 1964 to examine the deposits. Preliminary estimates indicated 910,000 tons of ore averaging 17.5 percent zinc, 0.6 percent copper, and 3.5 ounces of silver. Also indicated was 1,868,000 tons of ore averaging 2.16 percent copper, 0.5 percent zinc, and 0.50 ounce of silver.[2] Yankee Canuck Oil and Mining Corp. of Toronto, Canada, completed its drilling program in Hancock County. Ore containing 0.50 percent beryllium oxide was reported. The company planned further evaluation and projection of

[2] Skillings' Mining Review. Denisons' Copper Prospect in State of Maine. Jan. 25, 1964, p. 6.

mining operations.[3] The Maine Geological Survey conducted mineral prospect evaluation studies in Piscataquis and Penobscot Counties. Roland F. Beers, Inc., discontinued its drilling operation for nickel, copper, and cobalt ores near East Union, Knox County.

REVIEW BY COUNTIES

Paving sand and gravel was produced in all counties by the Maine State Highway Commission. Output was obtained both by the Commission's own crews and by contract workers. Four municipalities in Androscoggin County, two in Hancock County, and one in Penobscot County produced sand and gravel for local road and street maintenance and repair. Some paving and fill gravel was produced by Acadia National Park in Hancock County. In addition, contractors produced sand and gravel for governmental agencies in Cumberland, Kennebec, Knox, and Oxford Counties.

Androscoggin.—Commercial output of sand and gravel was reported from 14 operations. Fifty-one percent of the material was processed for use chiefly as building and paving material. Principal producers were Lewiston Crushed Stone Co., Inc., Lewiston; Blue Rock Sand and Gravel, Leeds; and G. A. Peterson Co., Auburn. Miscellaneous clay used for manufacturing building brick was produced from open pits near Auburn by Morin Brick Co. and Dennis Brick Co.

TABLE 5.—Value of mineral production in Maine, by counties

County	1962	1963	Minerals produced in 1963 in order of vlaue
Androscoggin	(1)	$377,781	Sand and gravel, clays.
Aroostook	$663,131	560,225	Sand and gravel, stone.
Cumberland	816,861	1,186,177	Sand and gravel, stone, clays.
Franklin	(1)	113,724	Sand and gravel.
Hancock	(1)	(1)	Stone, sand and gravel, clays.
Kennebec	293,061	614,357	Sand and gravel, stone.
Knox	(1)	(1)	Cement, stone, sand and gravel.
Lincoln	62,709	(1)	Sand and gravel.
Oxford	199,514	222,313	Sand and gravel, feldspar, stone, gem stones.
Penobscot	946,533	769,035	Sand and gravel.
Piscataquis	(1)	(1)	Sand and gravel, stone.
Sagadahoc	(1)	87,556	Sand and gravel.
Somerset	198,953	329,532	Sand and gravel, stone.
Waldo	(1)	(1)	Do.
Washington	(1)	(1)	Sand and gravel, peat.
York	(1)	(1)	Stone, sand and gravel, clays.
Undistributed [2]	11,766,873	9,843,672	
Total	[3] 14,947,000	14,104,000	

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes value of some gem stones, sand and gravel (1962), and mica (1962) that cannot be assigned to specific counties; and values indicated by footnote 1.
[3] Data do not add to total because of rounding.

Aroostook.—Commercial production of sand and gravel increased slightly and was used principally as building, paving, and fill material. Producers were Bull Brothers, Inc., Presque Isle; Lawrence E. Burleigh, Houlton; Quint Brothers, Hodgdon; and Bangor, Aroostook Railroad, Houlton. Limestone, used mainly for concrete aggregate

[3] Mining World. September 1962, v. 24, No. 10, p. 80

and railroad ballast, was quarried near Presque Isle by McKay Rock Products, Inc.

Cumberland.—Output of commercial sand and gravel increased 10 percent and totaled 590,000 tons. Producers were Cumberland Sand & Gravel Co., Inc., and Maynard W. Robinson & Sons, both near Cumberland; Leroy S. Prout Sand and Gravel, Scarborough; P. E. Hamlin, Portland; Harry C. Crooker & Sons, Inc., Brunswick; Fred H. Jordan, South Portland; and Clifton R. Tandberg, Windham. Granite used for aggregate and riprap was quarried by Cook & Co., Portland. Blue Rock Quarry produced stone for concrete aggregate and riprap at Westbrook. Miscellaneous clay used for manufacturing brick was produced by Lachance Bros. Brick Co., Gorham; Fred S. Liberty & Sons, Inc., North Yarmouth; and Royal River Brick Co., Inc., Gray. Roger S. Blais, at Gray, went out of business.

Franklin.—Commercial sand and gravel used for building and paving was recovered from pits near Wilton and Weld. Brown Co., a paper manufacturer at Berlin, N.H., produced fill and paving sand and gravel on company-owned property in the county for use in building and maintaining access roads.

Hancock.—Hancock County continued to lead in production of granite. Dimension granite was produced by Deer Island Granite Corp., Stonington; Grenchi & Ellis, Inc., Hall Quarry; and Fred Weinninger, Franklin. Most of the stone was dressed for use in construction and architectural applications. Commercial sand and gravel production decreased compared with that of 1962. Most of the putput was used for paving. Producers were Blue Hill Gravel Pit, Blue Hill; Raymond F. Sargent, Ellsworth; Alvin R. Whitten, Winter Harbor; Harold MacQuinn, Inc., Bar Harbor; and Byron P. Young, Gouldsboro. Rowantrees, Inc., recovered stoneware clay from a pit near East Blue Hill for use in manufacturing art pottery.

Kennebec.—Compared with that of 1962, commercial production of sand and gravel decreased; output by Government-and-contractor operations increased sharply. Commercial output came from the operations of V. E. Dunn & Son, Augusta, and Calvin Rundstrom, Gardiner. Blue Rock Quarry produced limestone for concrete aggregate and roadstone at Sidney.

Knox.—Portland and masonry cements were produced at Thomaston by Dragon Cement Co., Inc., Division of Martin Marietta Corp. Cement rock quarried nearby was the principal cement raw material utilized by the company. The county continued as a leading stone-producing area. Rockland-Rockport Lime Co., Rockland, and Lime Products Corp., Union, quarried limestone. The material was used principally for agstone, paper manufacture, and concrete aggregate. Limited quantities of stone for poultry grit and packaged dry-mixed concrete were produced by Rockland-Rockport Lime Co., Inc. Dimension granite was quarried by Hocking Granite Industries, Inc., Clark Island. Most of the material was fabricated for use in construction and architectural applications as well as for monuments, curbing, and flagging. Some granite for riprap and stone sand also was produced. Chester R. Wallace & Son, Inc., Warren, continued to be the only sand and gravel producer.

Lincoln.—Building, paving, and fill gravel was produced from a pit near Sheepscott by Howard R. Wright.

Oxford.—Crude feldspar was recovered principally from the Perham, Waisanen, and Conant mines. Bell Minerals Co., the leading producer, operated the Perham and Waisanen mines. The company subleased the Perham mine to two other operators for part of the year. All of the crude material was ground at Bell Minerals Co.'s mill at West Paris. Feldspar was ground for ceramic uses, including electrical porcelain, sanitary tile, and pottery, for soaps and abrasives, and for metal polish. Commercial sand and gravel was produced by Donald E. Wood from a pit near Norway and by Brown Co. on company-owned land. Mineral Materials Co. produced quartz which was crushed and sized for use as exposed aggregate in precast construction at an operation near Norway. The company operated for only 3 months. No hand-cobbed beryl or sheet mica was recovered from county mines.

Penobscot.—Commercial sand and gravel production totaled 285,000 tons, a 15-percent increase compared with that of 1962. Seven principal operations were active, mainly near Bangor, Lincoln, and Stillwater. The material was used principally for highway construction and maintenance and for ice control.

Piscataquis.—Slate for heavy switch gear panels and flagging was produced at Monson by Portland-Monson Slate Co. The company recovered slate from its No. 2 and 4 underground mines by the block-caving method. The slate was fabricated at the local finishing mill; some of the finished flagstone and electrical slate were exported to Canada. No commercial sand and gravel production was reported.

Sagadahoc.—Commercial sand and gravel was produced by Jack's Pit and Andrew R. Maynard, Inc., both near Topsham, and Almon R. Mitchell, Bath. All of the output was used as construction material. No sheet mica was recovered.

Somerset.—Crushed limestone for road material was produced at a portable plant west of Newport by H. E. Sargent, Inc. Steelstone Corp., Fairfield, and Donald J. Gurney, Inc., Smithfield, produced and processed sand and gravel.

Waldo.—Grenchi & Ellis, Inc., produced dimension granite for architectural work at its Frankfort quarry. No commercial sand and gravel production was reported.

Washington.—Commercial sand and gravel was recovered by Main Central Railroad, East Machias, and Hill & Sennett, Machias.

York.—Dimension granite for dressed architectural stone and riprap was produced at the Swenson Pink Quarry, Wells, and the Swenson Red Quarry, York, by John Swenson Granite Co., Inc., of Concord, N.H. Sand and gravel production by commercial operations totaled 235,000 tons, compared with 243,000 tons in 1962. Producers were Philip R. Boston, North Berwick; Lucien Bourque, Inc., Biddeford; I. H. Fenderson, Inc., Saco; Genest Concrete Works, Inc., Sanford; Alphonse Marcuri, York Harbor; and Abbott Bros., York. Clay for manufacturing brick was produced by Morin & Sons, Inc. Eliot.

The Mineral Industry of Maryland

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Maryland Geological Survey for collecting information on all minerals except fuels.

By N. A. Eilertsen [1]

VALUE of mineral production in Maryland increased 6 percent over that of 1962 and established a new high of $70.2 million in 1963. The upward trend in total value of mineral output was maintained by a significant increase in production and sales of crushed stone and coal. For the third consecutive year, cement, sand and gravel, and coal were the leading commodities, in decreasing order of dollar value.

Baltimore County with a large production of stone, sand and gravel, and clays ranked first in mineral output followed by the cement-producing counties of Carroll, Washington, and Frederick.

TABLE 1.—Mineral production in Maryland [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	593	$899	580	$897
Coal (bituminous)—do	821	3,168	1,162	4,330
Gem stones	(2)	3	(2)	3
Natural gas—million cubic feet	2,472	667	1,633	439
Sand and gravel—thousand short tons	12,762	16,816	13,310	16,063
Stone—do	11,610	22,595	13,012	26,407
Value of items that cannot be disclosed: Cement (portland and masonry), diatomite, greensand marl, lime, peat, potassium salts, talc, and soapstone		22,481		22,111
Total		66,629		70,250

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.

A constant dollar series has been prepared in which the bias caused by price-level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

[1] Mining engineer, Bureau of Mines, College Park, Md.

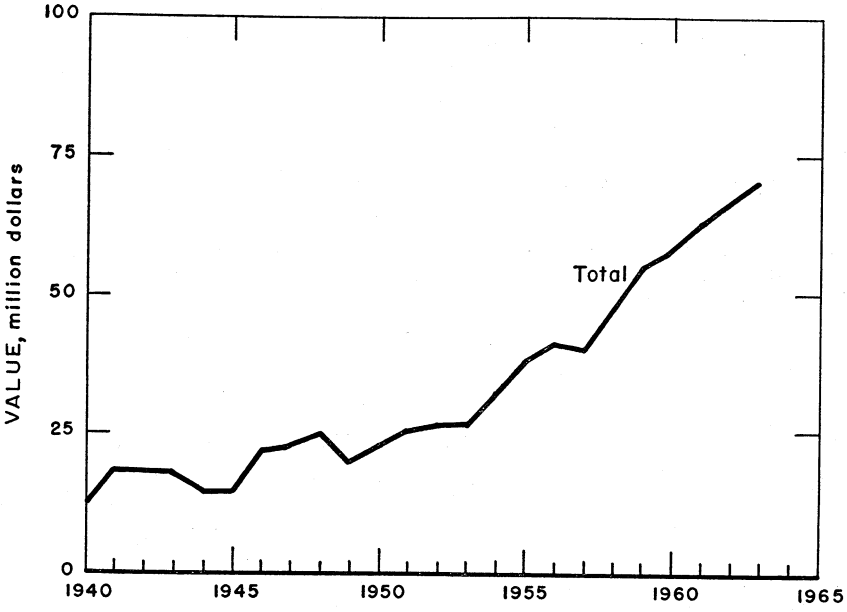


FIGURE 1.—Total value of mineral production in Maryland, 1940–63.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$29,355	1958	$46,131
1953	28,098	1959	54,170
1954	32,026	1960	57,472
1955	36,422	1961	63,172
1956	39,916	1962	67,355
1957	40,088	1963	71,141

Water.—The Bureau of Mines canvassed the mineral producers in 1963 for water usage in 1962. The sand and gravel industry used large quantities of water in processing the output of pits and quarries to make a higher quality product. The sand and gravel industry recirculated a large quantity of water, thereby helping conserve a valuable natural resource. No coal-washing plants were active in the State, and only a small quantity was used in the natural gas industry in 1962.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Type of operation	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	426.1	20.0	446.1	407.2	18.9	18.78
Nonmetal mines and mills	1.1		1.1	1.1		1.18
Sand and gravel plants	4,767.6	2,293.4	7,061.0	4,395.1	372.5	283.52
Total	5,194.8	2,313.4	7,508.2	4,803.4	391.4	128.60

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of portland and masonry cement increased 7 percent compared with those of 1962. Production of portland cement was up 9 percent; plants operated at 87 percent of rated capacity. Nearly 75 percent of the cement was manufactured by the dry process. Over 72 percent of the electric power used in cement manufacture was purchased from local utility companies. Consumption of electrical energy increased 8 percent.

Cement was produced from plants in Carroll, Frederick, and Washington Counties and marketed in several States. Substantial quantities were used in Maryland, Virginia, the District of Columbia, and Pennsylvania. Over one-half of the total output was used in ready-mixed concrete. Large quantities also were consigned to concrete product manufacturers, highway contractors, and building materials dealers. Carroll County continued as the leading producer.

Clays.—Total output of clays was 2 percent less than in 1962, but there was no significant change in total value. A decrease of 3 percent in production of miscellaneous clay was offset by an increase of 27 percent in fire clay.

Clay was produced in nine counties. Baltimore was the only source of ball clay. Harford was the leading of the three fire-clay producing counties. Baltimore County and Baltimore City combined led the State in the total production of clays and ranked first in production of miscellaneous clay. Prince Georges and Washington Counties were second and third in production of miscellaneous clay. Miscellaneous clay was used mostly in manufacturing building brick and cement. Fire-clay products included firebrick and block refractories, and heavy clay products such as vitrified sewer pipe. Stoneware, pottery, floor and wall tile, firebrick and block, and vitrified sewer pipe are included in the uses made of ball clay.

Diatomite.—Diatomaceous earth was produced from a deposit in Calvert County.

Gem Stones.—Collection of a wide variety of semiprecious gem material and mineral specimens in Allegany, Carroll, Washington, and Cecil Counties was reported by hobbyists. Minerals collected included williamsite, calcite, iridescent siderite, barite crystals, bornite, malachite, and magnetite-chlorite schist.

Lime.—Agricultural lime output decreased 5 percent; total lime production remained nearly static. Lime was produced from three plants in Frederick County. A company in Allegany County regenerated lime in its manufacturing process.

Marl, Greensand.—A plant in Calvert County prepared greensand marl for marketing as a natural fertilizer and soil conditioner.

Perlite (Expanded).—Two plants, one in Baltimore and the other near Washington, D.C., in Prince Georges County, continued to produce expanded perlite for market. Crude perlite was shipped in from Colorado and New Mexico. Plant products were principally marketed for use in building plaster, in concrete aggregate, and as filter aid.

Pigments.—Natural and manufactured iron oxide pigments were produced at a plant in Prince Georges County. Two large plants near Baltimore manufactured titanium dioxide pigments from titanium mineral concentrates. All raw ores and concentrates used in pigment manufacture were from sources outside the State.

Potassium Salts.—Potassium sulfate continued to be recovered as a byproduct of cement manufacture in Washington County. Output was at a lower rate than in 1962.

Sand and Gravel.—Total production of sand and gravel increased 4 percent. The average value per ton was $1.21, compared with $1.32 in 1962. Decrease in overall unit value was largely due to increased output of unprocessed bank gravel used for fill. Tonnage of sand for making glass decreased 24 percent, and the quantity for grinding and polishing rose 42 percent.

The ratio of sand to gravel produced was 1:1.25. Commercial sand and gravel was produced in 16 counties. Prince Georges County led with 53 percent of total commercial tonnage output, followed by Anne Arundel, Baltimore, and Cecil Counties. Government-and-contractor sand and gravel tonnage increased 27 percent, with operations active principally in Talbot, Worcester, and Cecil Counties.

TABLE 4.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

	1962		1963	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Structural	3,366	$4,120	3,232	$4,091
Paving	2,347	3,193	2,285	2,831
Fill	(1)	(1)	39	21
Other [2]	1,115	1,916	366	801
Total	6,828	9,229	5,922	7,744
Gravel:				
Structural	1,914	3,568	2,048	3,698
Paving	2,028	2,719	2,354	2,672
Fill	703	354	2,231	1,218
Other	1,131	884	[3] 555	660
Total	5,776	7,525	7,188	8,248
Total sand and gravel	12,604	16,754	13,110	15,992
Government-and-contractor operations:				
Sand	1	2	5	2
Gravel	157	60	195	69
Total sand and gravel	158	62	200	71
All operations:				
Sand	6,829	9,231	5,927	7,746
Gravel	5,933	7,585	7,383	8,317
Total	12,762	16,816	13,310	16,063

[1] Figure withheld to avoid disclosing individual company data; included with "Other."
[2] Includes glass, grinding and polishing, engine, filtration (1963), railroad ballast (1962), and other sand, and data indicated by footnote 1.
[3] Includes railroad ballast.

Stone.—Production of stone increased 12 percent over that of 1962 and accounted for over one-third of the value of all mineral production in Maryland. Output of limestone, the leading industrial stone, increased 4 percent. Crushed limestone was used mainly for concrete aggregate and road-base material and as a raw material in cement manufacture. Production of basalt increased 25 percent owing to the demand for concrete and road base. Quantity of granite for dimension stone decreased 60 percent, but production of crushed granite was greatly increased for use as riprap and concrete aggregate. Production of crushed sandstone, more than triple the 1962 output, was used as refractory stone, concrete aggregate, and for cement manufacture. More dimension sandstone was quarried for building stone than in 1962. Marble output was processed as dressed building stone or crushed for terrazzo. Production of oystershell increased 18 percent, mainly for use as poultry grit and lime.

The leading stone producing counties in order of tonnage produced were Baltimore, Montgomery, Frederick, Cecil, Washington, Howard, and Carroll.

Talc and Soapstone.—Output of talc and soapstone decreased 24 percent. Most of the crushed material was ground and sold for asphalt filler, roofing granules, and foundry facings. Soapstone was sawed and processed for industrial use at a plant in Harford County.

Two quarries, one producing soapstone in Carroll County and the other a talc operation in Harford County, were active.

Vermiculite (Exfoliated).—Crude vermiculite from Montana and South Carolina was exfoliated at a plant in Prince Georges County.

MINERAL FUELS

Coal (Bituminous).—Production of coal exceeded 1 million tons for the first time since 1948 with an output of 1.2 million tons, a gain of 42 percent over 1962 output. Maryland coal fields are confined to Garrett and Allegany Counties. During the year, 63 percent of total production came from 31 strip mines (2 more than in 1962). The remaining output was from underground mines, which increased by 4 to total 39 active mines. Tonnage of coal produced increased 57 percent for strip mines and 21 percent for underground mines. Two strip mines, both operating in the Kittanning and Freeport seams, and a third mining coal from the Franklin, Bakerstown, and Freeport seams, produced 67 percent of strip-mine production. Twelve mines working in the Pittsburgh seam accounted for an additional 9 percent of strip-mine output. Of the total 39 active underground mines in Garrett and Allegany Counties, 9 mines operating in the Freeport seam in Garrett County produced nearly 40 percent of underground output. Strip-mine coal was valued at an average of $3.51 per short ton, compared with $4.10 per ton for coal mined underground. The average overall value per ton of coal produced was $3.73, a decrease of $0.13 per ton from the 1962 average. Garrett County produced 82 percent of all the coal mined in Maryland.

Coal mining in the State is not conducive to large-scale operations, so output of coal is obtained from numerous small nonmechanized underground mines and from strip mines operating along contours of

steeply sloping hillsides. However, 64 percent of underground production was cut by machine, 63 percent was power-drilled, and 8 percent was hand-loaded onto face or room conveyors. There were no facilities for mechanical cleaning, but 12 mines with 23 percent of total State output crushed and sized their products.

Coke and Chemicals.—Bethlehem Steel Corp. produced coke at its Sparrows Point furnace plant of 757 Koppers-Becker ovens. Yield of coproducts included coke breeze, coke oven gas, ammonium sulfate, crude coal tar, pitch of tar (soft), crude chemical oil, intermediate light oil, crude light oil and derivatives (benzene, toluene, xylene), and crude naphthalene solidifying under 74° C. Total coke distribution to blast-furnace plants in Maryland amounted to 3 million tons.

Natural Gas and Petroleum.—Mountain Lake Park and Accident Fields in Garrett County continued to be the only sources of natural gas in Maryland. Production continued at a steady rate.

There was no production of petroleum in Maryland in 1963, but American Bitumuls & Asphalt Co., American Oil Co., and Humble Oil and Refining Co. operated refineries in the Baltimore area with a total capacity of 28,900 [2] barrels of crude per day. End products included lubricating oil and asphalt.

Peat.—A modern plant operating in Kent County increased its production of reed-sedge peat obtained from a bog adjacent to the plant near Betterton. Plant output was marketed in bulk and in packages. A company was organized in Garrett County to exploit a peat bog near McHenry. Following drainage by ditching the 2 to 9 feet thick bed of peat was mechanically scooped and transported to windrows for drying and shredding. The product was offered initially in bulk to gardeners and nurserymen.

METALS

Copper.—High-purity copper was produced at the Hawkins Point plant of the Kennecott Copper Corp. and at the Baltimore plant of the American Smelting and Refining Co. from copper anodes shipped from smelters to the eastern seaboard for electrolytic refining.

Iron and Steel.—The Bethlehem Steel Co. produced basic and foundry pig iron at its Sparrows Point plant. Addition of an alloy and tool steel bar mill was authorized for the Bethlehem plant. The Sparrows Point plant won first place in an accident prevention competition against 18 of America's largest steel plants (the 1962–63 Metals Section Contest of the National Safety Council). Armco Steel plans to install a vacuum arc melting furnace at its Baltimore works [3] for the production of high-quality stainless steel for use in missiles, supersonic aircraft, and nuclear reactors.

REVIEW BY COUNTIES

Allegany.—County output of coal increased 28 percent, largely owing to the added number of strip mines in operation which increased by 7 to a total of 20. Output from strip mines increased 31

[2] Oil and Gas Journal. V. 62, No. 14, Apr. 6, 1964, p 125.
[3] American Metal Market, Oct. 10, 1963.

percent. Tonnage of coal from underground mines increased 25 percent with 17 mines operating, compared with 16 in 1962. Most production was from the Freeport, Franklin, and Bakerstown seams. Largest single strip-mine operator was the Moran Coal Co. with an output of about 20,000 tons of coal. The W. & W. Coal Co., operating two underground mines in Allegany County, produced about 40,000 tons.

Sand and gravel increased 26 percent in tonnage and 13 percent in value. Through purchase during the year, the Manley Sand Division of the Martin-Marietta Corp. took over operation of the quartzite sand plant of the Cumberland Cement and Supply Co. The plant is to be expanded for supplying silica sand to eastern glass manufacturers. Production during the year was mainly grinding and polishing, glass, and structural sand. The Pittsburgh Plate Glass Co. commenced installation of a new facility at Cumberland to employ the "float glass" process for the manufacture of high-quality plate glass.[4] The Cumberland Cement and Supply Co. continued to produce washed and screened structural and paving sand and gravel from its River No. 3 plant.

TABLE 5.—Value of mineral production in Maryland, by counties[1]

County	1962	1963	Minerals produced in 1963 in order of value
Allegany	1,897,179	2,389,429	Coal, sand and gravel, stone, clays, gem stones.
Anne Arundel	2,127,469	1,842,345	Sand and gravel.
Baltimore	14,113,015	13,317,155	Stone, sand and gravel, clays.
Calvert	(2)	(2)	Greensand marl, diatomite.
Caroline	(2)	(2)	Sand and gravel.
Carroll	(2)	(2)	Cement, stone, clays, soapstone, gem stones.
Cecil	2,920,620	4,389,880	Stone, sand and gravel, clays, gem stones.
Charles	----------	348,000	Sand and gravel.
Dorchester	(2)	(2)	Sand and gravel, stone.
Frederick	8,039,934	8,485,833	Cement, stone, lime, sand and gravel.
Garrett	[3] 3,271,160	4,294,380	Coal, natural gas, stone, sand and gravel, peat.
Harford	1,340,296	1,549,300	Stone, sand and gravel, clay, talc, and soapstone.
Howard	(2)	(2)	Stone, sand and gravel.
Kent	32,303	38,419	Peat, clays.
Montgomery	(2)	(2)	Stone.
Prince Georges	9,164,079	8,296,197	Sand and gravel, clays.
St. Marys	(2)	(2)	Sand and gravel.
Somerset	----------	(2)	Do.
Talbot	(2)	(2)	Do.
Washington	(2)	(2)	Cement, stone, clays, potassium salts, sand and gravel, gem stones.
Wicomico	[3] 111,113	112,284	Sand and gravel, clays.
Worcester	[3] 33,421	37,315	Sand and gravel.
Undistributed	[3] 23,577,834	25,149,600	
Total	66,629,000	70,250,000	

[1] Queen Annes County is not listed because no production was reported.
[2] Figure withheld to avoid disclosing confidential data; included with "Undistributed."
[3] Revised figure.

Two limestone quarries near Cumberland and Flintstone operated by the Fry Coal and Stone Co. marketed crushed stone for use as concrete aggregate and roadstone. Fire clay for manufacturing firebrick and block was produced by Kaiser Refractories & Chemicals Division of the Kaiser Aluminum and Chemicals Corp. from a strip mine and an underground operation near Frostburg. A mineral collector re-

[4] Ceramic Industry. V. 81, No. 5, November 1963, p. 29.

ported recovery of a small quantity of iridescent siderite and barite crystals in claystone concretions from clay pits near Mount Savage.

Anne Arundel.—With total output exceeding 1.6 million tons, the county ranked third in production and value of sand and gravel. Tonnage increased 10 percent over that of 1962. Output, chiefly prepared building and paving sand and gravel and bank-run material for fill, was produced from pits near Baltimore, Linthicum, Hanover, Gambrills, Odenton, Davidsonville, and Weysons Corner. Reliable Asphalt, at its captive sand and gravel pit near Millersville, produced asphalt mixes, mostly for county roads and parking lots.

Baltimore and Baltimore City.—Baltimore continued to be first among the 22 mineral-producing counties in the State, though the value of mineral output decreased 6 percent. Stone was the leading mineral produced, comprising over three-quarters of the total value of county output. The county ranked second in the production of sand and gravel. Harry T. Campbell Sons' Corp., subsidiary of The Flintkote Co., mined limestone at its Texas and Marriottsville quarries, crushing output for concrete aggregate, roadstone, paint and rubber filler, agriculture, stone sand, railroad ballast, and other uses. The Arundel Corp. crushed limestone at Greenspring for road material. Basalt, crushed chiefly for concrete aggregate and roadstone, was produced by the J. E. Baker Co. at the Blue Mount quarry near White Hall; The Arundel Corp., Baltimore City; and The Dooley Stone Co. near Hyde. Dimension quartzite for dressed or cut architectural stone, irregular-shaped rough construction stone, and flagging was quarried by the C.E. Weaver Stone Co., Butler. Miscellaneous stone (serpentine) was quarried near Reisterstown and crushed for use as road material. Crushed, screened, and sized oystershell was produced near Baltimore for poultry grit and lime. Commercial sand and gravel output (third highest in the State) decreased 5 percent in tonnage and 7 percent in value. Five pits were operated during the year. Output, mainly used for building and paving sand and gravel and for ready-mixed concrete, was recovered near Baltimore, Landsdowne, White Marsh, and Overlea.

Miscellaneous clay for building brick was obtained from open-pit mines by two companies near Baltimore. The United Brick Mines Corp., the only Maryland producer of ball clay, modernized its loading facilities for crushed clay. Clay output was used in manufacturing pottery and stoneware, floor and wall tile, refractories, and heavy clay products.

Crude perlite purchased in New Mexico was expanded at a Baltimore plant for use chiefly as an aggregate in building plaster.

Gypsum imported from eastern Canada was calcined at two plants in Baltimore for manufacture of a wide range of building products including wallboard, lath, and basecoat plasters.

Calvert.—Greensand marl (glauconite) produced by Kaylorite Corp. (Dunkirk) was marketed for use as a natural soil conditioner. A small tonnage of diatomite from a bed overlying the greensand marl deposit was shipped for experimental use.

Caroline.—Cook and Son produced sand and gravel at Greensboro. The processed material was used for paving and building construction.

Carroll.—Value of mineral production in the county, second-ranked mineral-producing area in the State, decreased 1 percent. Shipments of cement increased, and the county continued to lead in the value of cement output. Lehigh Portland Cement Co., Union Bridge, produced crushed limestone, sandstone, and shale for manufacturing cement at its three-kiln plant. Types I and II (general use and moderate heat) and Type III (high-early-strength) portland cements and masonry cement were produced. Most shipments were in bulk by truck to ready-mixed concrete companies, highway contractors, and concrete product manufacturers.

Large quantities of limestone were mined and crushed by two operators for use in manufacturing cement and for concrete aggregate and roadstone. Soapstone was mined at the Marriottsville open pit by Liberty Talc Mines, Inc. Most of the output was transferred to the company's Sykesville plant for grinding and sizing. Processed material was prepared for use in roofing and foundry facings and as an asphalt filler. Copper minerals and magnetite-chlorite schist rock specimens were reportedly found in small quantity near Sykesville.

Cecil.—Production of sand and gravel increased 23 percent with a nearly corresponding increase in value. Output was chiefly processed for use in ready-mixed concrete and for paving and building construction. Tonnage of crushed granite and basalt increased 46 percent to meet the demand for riprap, concrete mix, and roadstone in highway construction. Port Deposit Granite Co. quarried rough dimension stone, and Harbison-Walker Refractories Co. manufactured silica brick from quartzite quarried and crushed at the Leslie operation near North East.

Plastic fire clay and some white clay were recovered from two open-pit mines for manufacturing refractory firebrick and block. Williamsite, a gem variety of serpentine, was collected in small quantity in the Conowingo area.

Charles.—Charles County Sand and Gravel Co., Inc., marketed bank-run and processed sand and gravel for building and paving construction.

Dorchester.—Production of washed and pit-run sand and gravel, chiefly for building and road construction and fill, was reported by J. Edwin Rosser, Inc., from operations near Federalsburg. A small quantity of unprocessed sand and gravel was obtained by various producers for use in paving.

J. M. Clayton, Co., Cambridge, processed oystershell for poultry grit and lime.

Frederick.—Cement production ranked first in value of county mineral output. The Alpha Portland Cement Co. manufactured portland and masonry cements by the wet process at Lime Kiln. Output was marketed both in and out of State in bulk and in bags, and shipments were by rail and truck. The largest consumers of cement were the ready-mixed concrete companies, followed by concrete product manufacturers. Other outlets for cement were highway contractors and building material dealers. Six operators near Frederick, Lime Kiln, Le Gore, Middletown, New London, and Woodsboro quarried and crushed limestone and cement rock, chiefly for concrete aggregate, roadstone, agricultural fines and for cement and lime manufacture.

Three operators of lime kilns near Le Gore, Woodsboro, and Middletown produced quicklime and hydrated lime, chiefly for agriculture. A small quantity of sand was produced for building and paving purposes. A large plant for production of lightweight aggregate was under construction near Woodsboro by the Lehigh Portland Cement Co.

Garrett.—Production of bituminous coal in the county increased 45 percent over that of 1962. Tonnage of coal from strip mining was up 64 percent with 11 mines in operation, 5 less than in 1962. Higher output of strip-mine coal was mainly due to significant production increases by the three leading mine operators, Buffalo, Moran, and Douglas Coal Companies, operating mainly in the Kittanning, Franklin, and Freeport seams. Underground coal output increased 20 percent, partly owing to an increase in the number of active mines from 19 to 22. The largest producers, Buffalo Coal Co. and F. and P. Coal Co., both increased output; Buffalo Coal Co. operated from the 48-inch-thick Freeport seam, and F. and P. Coal Co. mined the 40-inch-thick Kittanning seam. Vetter Brothers, Inc., mined and crushed limestone at the Browning quarry near Oakland. Output was used for concrete aggregate. Garrett County Processing and Packaging Corp. commenced production of humus peat from a bog near McHenry.

Harford.—Production of sand and gravel dropped 21 percent. Four operators, one fewer than in 1962, produced and processed paving sand and gravel, masonry sand, and bank-run material for fill at Aberdeen, Abingdon, Edgewood, and Joppa. Gatch Crushed Stone Co., Churchville, and D. M. Stoltzfus & Son, Inc., Aberdeen, quarried and crushed basalt (traprock) for road material. Maryland Green Marble Corp. quarried marble and produced sawed, cut, and dressed dimension stone for building interiors and crushed marble for terrazzo. Talc was mined by Harford Talc and Quartz Co., Inc., Dublin, and processed for a number of industrial applications. Plastic clay was recovered from a pit near Edgewood for use in the manufacture of heavy clay products.

Howard.—The Arundel Corp. produced crushed basalt (traprock) for concrete aggregate and roadstone at a quarry and crushing plant near Savage. Howard-Montgomery Crushed Stone, Inc., Clarksville, mined, crushed, and sized limestone for concrete aggregate, roadstone, and paving ingredient. A small quantity of sand and bank-run gravel was produced for State road maintenance.

Kent.—Chestertown Brick Co., Chestertown, recovered miscellaneous clay from an open pit for manufacturing building brick. Reed-sedge peat from a bog near Betterton was processed for market by Maryland Peat Humus Co. Product of the plant was shipped in bulk and in package for agricultural use.

Montgomery.—Dimension mica schist for rough and dressed building stone, flagging, and rubble was quarried near Bethesda by Stonyhurst Quarries. Rockville Crushed Stone Co., Rockville, mined and crushed conglomerate (traprock) for concrete aggregate and roadstone.

Prince Georges.—The county ranked fifth in the value of mineral production and continued to be first in output of sand and gravel. The structural and paving market absorbed most of the county output. Large quantities of bank-run material were used for fill. Fifty-nine

percent of sand and gravel output was prepared by washing and screening. Most of the sources of sand and gravel were southeast of Washington, D.C., north of Beltsville, and east of Bowie. Potomac Sand and Gravel Co., a subsidiary of Dravo Corp., conducted dredging operations on the Potomac River and operated two crushing, screening, and washing plants in the District of Columbia for production of various grades of sand and gravel. Following a comprehensive study, the U.S. Geological Survey reported there were large deposits of good-quality sand and gravel in the vicinity of Beltsville.

Miscellaneous clay, chiefly for building brick, was obtained from open pits by West Brothers Brick Co. near Washington, D.C., and the Washington Brick Co., Muirkirk. The Atlantic Perlite Co., Washington, D.C., expanded Colorado perlite for use in building plaster and concrete aggregate. Crude vermiculite obtained outside the State was exfoliated by the Zonolite Co. at Beaver Heights. Mineral Pigments Corp. manufactured a variety of iron oxide pigments at a plant in Muirkirk.

St. Marys.—Sand and gravel for building, paving, fill, and surface treatment uses was processed in stationary plants near Leonardtown and Mechanicsville.

Somerset.—Unprocessed sand and gravel was recovered by various producers for paving and fill.

Talbot.—A sizable quantity of Government-and-contractor gravel was produced for State road work.

Washington.—The value of mineral production decreased 2 percent, but the county remained third among the mineral-producing counties. Modest gains were made in the tonnage output of stone and clay, which increased 3 and 2 percent respectively. Cement was the leading commodity, comprising 79 percent of the total value of minerals produced.

Marquette Cement Manufacturing Co. quarried and crushed limestone, chiefly for cement manufacture at its Security plant of five 125-foot and one 140-foot rotary kilns near Hagerstown. General use and moderate heat (Types I and II) and high-early-strength (Type III) portland cements and masonry cement were produced by the dry process. Shipments were mostly intrastate and to the District of Columbia, Virginia, and Pennsylvania.

Fry Coal and Stone Co., Division of Martin-Marietta Corp., produced limestone at quarries near Hagerstown, Pinesburg, Hancock, and Boonsboro. Most of the crushed and screened material was used for concrete aggregate and roadstone. Miscellaneous clay and shale was produced near Williamsport by Victor Cushwa & Sons, Inc., for earth fill, cement and building brick manufacture, and fertilizer filler. Byproduct potassium sulfate was recovered from cement clinker at the Security plant of the Marquette Cement Manufacturing Co. Specimen calcite was obtained in minor quantity near Cavetown by a mineral collector. A small quantity of bank-run sand was produced under contract for the National Park Service.

Wicomico.—Sand and gravel for building, paving, concrete products the manufacture of building brick was recovered from a pit near Salisbury, Hebron, Sharptown, and Fruitland. Miscellaneous clay for the manufacture of building brick was recovered from a pit near Salisbury by the Salisbury Brick Co., Inc.

747-416—64——35

Worcester.—Mervin L. Blades & Son processed sand and gravel for building and road construction at a dredging operation near Pocomoke City. Sand and gravel for highway construction, maintenance, and repair was produced by crews of the Worcester County Roads Board.

An article described early iron ore mining in the county.[5] From 1812 to 1847 about 700 tons of pig iron was produced annually at the Nassawango Iron Furnace from low-grade bog iron ore dug from surrounding swamps. Wood charcoal produced from the surrounding forest was used for fuel, and oystershell from Sinepuxent Bay was limestone flux for the process. While the passage of time has erased the last vestige of the pioneers, who built a town named Furnaceville, the remnant of a large brick furnace still remains. A roadside marker 5 miles from Snow Hill on Maryland Route 12 points to the site.

[5] The Washington Post, Potomac Supplement, Apr. 26, 1964.

The Mineral Industry of Massachusetts

By Robert W. Metcalf [1]

VALUE of Massachusetts mineral production rose to $32.7 million, a new high, 9 percent above that of 1962 and 6 percent over 1961, the previous record year. Because of increased multifamily, commercial, and school building, and a vigorous highway construction program stimulated by Federal and State assistance, production and value of stone and sand and gravel broke all previous records. Value of lime output and quantity of clay produced also were the highest on record. Consumption of shale for lightweight aggregate increased sharply. Quantity of peat increased, although the value declined slightly.

Middlesex County ranked first, measured by both quantity and value of mineral production. In terms of value, Berkshire and Norfolk Counties were in second and third places, respectively.

TABLE 1.—Mineral production in Massachusetts [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays.....short tons	125,470	$96	157,442	$213
Gem stones	(2)	2	(2)	2
Lime.....short tons	148,401	2,337	144,889	2,426
Sand and gravel.....do	17,565,834	15,026	19,904,708	15,592
Stone.....do	4,984,662	12,541	5,570,305	14,396
Value of items that cannot be disclosed: Mineral fuels and nonmetals		33		32
Total		30,035		32,661

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

[1] Mineral specialist, Bureau of Mines, Pittsburgh, Pa.

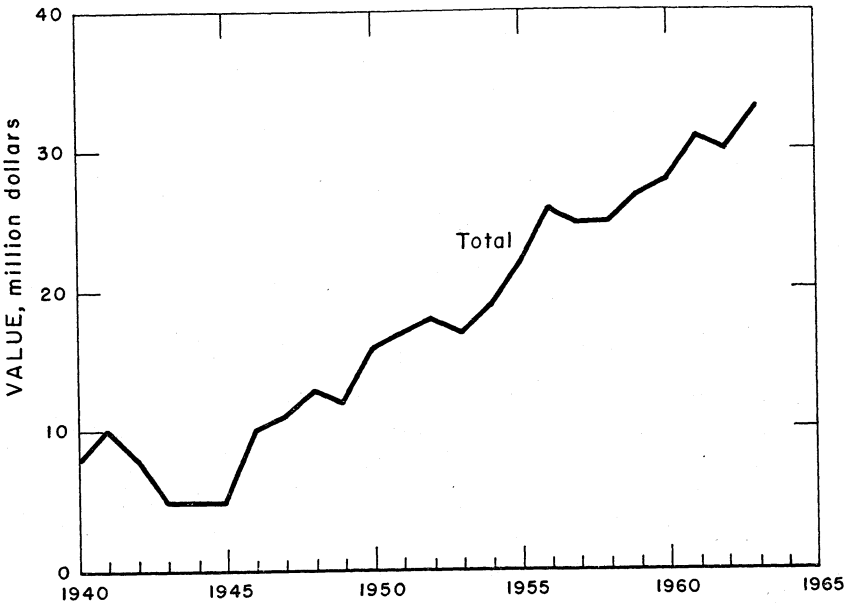


FIGURE 1.—Total value of mineral production in Massachusetts, 1940–63.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$19,661	1958	$24,104
1953	17,898	1959	26,086
1954	19,576	1960	28,098
1955	22,677	1961	30,849
1956	24,545	1962	30,243
1957	25,192	1963	32,822

Water.—A canvas of water use and consumption in the mineral industries was conducted by the Bureau of Mines in 1963 for the year 1962. In Massachusetts, water used in that year totaled 4.4 billion gallons, which was divided on an approximately 3-to-1 basis between "sand and gravel" and "quarries and mills," respectively. The amount of new water needed per dollar value of production for the quarries and mills group was 13.40 gallons, while that for the sand and gravel industry, where washing is much more extensively used, was 162.79 gallons.

The canvass also covered the treatment accorded to new water, recycled water, and discharged water. Virtually none of the new water used in mineral industry processing received treatment before use, although some was precipitated. Over 1.5 billion gallons of recycled water (nearly 90 percent of the total recycled) was given no treatment other than settling, and the balance had no treatment. Of the reported 2.4 billion gallons of water discharged, 54 percent was discharged on the surface, 45 percent to ground water and 1 percent into sewers.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Types of operation	New water	Water recirculated	Total water use	Water discharged	Water consumed	Gallons of new water per dollar value of production
Quarries and mills	168	957	1,125	145	23	13.40
Sand and gravel operations	2,446	821	3,267	2,297	149	162.79
Other nonmetal mines and mills	(1)	----------	(1)	(1)	----------	.1
Total	2,614	1,778	4,392	2,442	172	94.50

[1] Less than 0.5 million gallons.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Atmospheric Gases.—Oxygen, nitrogen, and argon were produced by the Air Reduction Co., Inc., at South Acton, Middlesex County.

Clays.—Production of clay rose 25 percent, slightly over production of the peak year, 1949. Three companies mined miscellaneous clay or shale for use in building brick. One firm used shale in manufacturing lightweight aggregates.

Gem Stones.—Mineral specimens were collected on a small scale by hobbyists at unspecified locations.

Gypsum.—Calcined gypsum products were manufactured at Charlestown, Suffolk County, from imported Nova Scotia crude.

Lime.—Production of lime was maintained at a high level. Output came only from Berkshire County, where three firms continued to burn and to market lime, chiefly for chemical consumption. Appreciable tonnages were consumed by building industries and smaller quantities were used in agriculture.

TABLE 4.—Lime sold or used by producers

Year	Short tons	Value	Year	Short tons	Value
1954–58 (average)	134,676	$2,022,658	1961	144,831	$2,306,710
1959	143,567	2,289,250	1962	148,401	2,337,027
1960	153,710	2,370,059	1963	144,889	2,425,699

Peat.—Production of peat rose about 12 percent, while the value decreased slightly. Peat was recovered by two companies; one each in Essex and Worcester Counties.

Perlite.—Colorado crude perlite was expanded at Roslindale, Suffolk County and sold for use chiefly in building plaster, in concrete aggregate, and as a soil conditioner. Output was lower in 1963, although average value per unit of sale increased slightly.

Sand and Gravel.—Output of sand and gravel rose to new records in both quantity and value. The increase was due especially to vigorous road building under the Federal road building plan, both for primary and for secondary roads. The average value per ton, however, dropped from $0.86 to $0.78, reflecting the lower average value of

gravel in 1963. Government-and-contractor tonnage was 20 percent of the total sand and gravel sold or used. Sixty-four percent of the total quantity was consumed in building and paving and about 26 percent for fill. Sand and gravel used for paving comprised 33 percent of combined Government-and-contractor and commercial tonnage. Small quantities of commercial sand and gravel were used as blast, filtration, and railroad ballast sand and as railroad ballast gravel. About 74 percent of the commercial output and 88 percent of Government-and-contractor tonnage was sold as washed, screened, or prepared material. Active commercial pits in 1963 totaled 219. More complete coverage accounted for the major portion of this increase in number of operating pits, compared with 163 reported in 1962. Production of sand and gravel in Middlesex County, the largest

TABLE 5.—Sand and gravel sold or used by producers, by classes of operations and uses

Class of operation and use	1962		1963	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Glass	109	$300		
Structural	2,910,098	2,952,482	2,973,120	$2,801,538
Paving	1,561,304	1,517,043	2,409,857	2,252,240
Fill	1,430,552	543,382	1,194,862	475,347
Blast	(1)	(1)	1,450	7,250
Filtration			1,450	7,250
Railroad ballast			1,191	884
Undistributed [2]	522,768	873,150	735,306	938,678
Total	6,424,831	5,886,357	7,317,236	6,483,187
Gravel:				
Structural	3,146,537	4,326,601	3,270,972	3,908,750
Paving	1,823,644	1,929,862	2,677,926	2,247,157
Fill	991,097	545,234	1,463,912	647,239
Other	405,653	275,320	818,403	641,101
Undistributed [3]	481,874	338,301	466,345	419,044
Total	6,848,805	7,415,318	8,697,558	7,863,291
Total sand and gravel	13,273,636	13,301,675	16,014,794	14,346,478
Government-and-contractor operations:				
Sand:				
Structural	100	100		
Paving	125,500	54,160	25,400	15,712
Fill	2,430,000	895,500		
Other	43,758	23,331	22,960	24,192
Total	2,599,358	973,091	48,360	39,904
Gravel:				
Paving	1,282,340	605,720	1,406,508	887,526
Fill	410,000	145,000	2,435,046	318,382
Other	500	500		
Total	1,692,840	751,220	3,841,554	1,205,908
Total sand and gravel	4,292,198	1,724,311	3,889,914	1,245,812
All operations:				
Sand	9,024,189	6,859,448	7,365,596	6,523,091
Gravel	8,541,645	8,166,538	12,539,112	9,069,199
Total	17,565,834	15,025,986	19,904,708	15,592,290

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes blast sand, ground sand (1962), molding sand, and sand for other uses.
[3] Includes railroad ballast and miscellaneous gravel.

producing county, rose nearly 2 million tons to 5.8 million tons. Other counties with production over 1 million tons included Bristol, Essex, Franklin, Hampden, Norfolk, and Worcester.

Government-and-contractor output was produced in all counties except Dukes, Nantucket, Suffolk, and Worcester. The largest tonnage of Government-and-contractor production in 1963 was reported from Franklin County (over 2.1 million tons), followed in descending order by Hampden, Bristol, and Plymouth Counties.

Stone.—Production of stone established record highs; tonnage was 6 percent higher than in the previous record year (1960) and value was 7 percent higher than in 1961, the former record year. The production of granite rubble, rough architectural granite, and granite curbing and flagging all increased substantially over the 1962 levels. Basalt, consumed largely for concrete aggregate and road material, was the most important stone in both quantity and value. Output of miscellaneous stone decreased, while production of granite and sandstone increased. Output of limestone was 5 percent higher than in 1962. Production of dimension stone (mostly granite, but with a small tonnage of dimension sandstone) advanced sharply to 125,100 short tons valued at $4.3 million, chiefly due to increased demand for rough architectural stone, rubble, and curbing. The active roadbuilding program was responsible for the large rise (16 percent over that of 1962) in use of stone for concrete aggregate and roadstone. This use also accounts for over 75 percent of the total stone sold or used in 1963. Output of riprap, although a small part of the total stone produced, was 28 percent greater than in 1962.

As in 1962, stone was quarried in all counties except Barnstable, Dukes, and Nantucket. The leading stone-producing county again was Middlesex, followed by Norfolk, Essex, Hampden, and Berkshire. In terms of value, the order of rank was Middlesex, Berkshire, Norfolk, Essex, and Hampden.

Roofing Granules.—Roofing granules were prepared by a company at Norwood, Norfolk County, from a miscellaneous stone (rhyolite) quarried at Wrentham. Both uncolored and artificially colored granules were marketed. Production was slightly less than in 1962, but average value per ton was higher.

TABLE 6.—Stone sold or used by producers, by uses

Use	1962		1963	
	Short tons	Value	Short tons	Value
Riprap	44,006	$66,885	56,378	$96,236
Concrete aggretate and roadstone	3,688,769	5,931,278	4,293,845	7,085,657
Agricultural (limestone)	175,438	546,275	177,943	558,632
Undistributed [1]	1,076,449	5,996,425	1.042,139	6,655,014
Total	4,984,662	12,540,863	5,570,305	14,395,539

[1] Includes dimension stone, furnace flux, railroad ballast, and other uses.

Vermiculite.—Domestic and South African vermiculite was exfoliated at plants in Hampshire, Middlesex, and Norfolk Counties for sale as a lightweight aggregate and for insulation. Production increased moderately over that of 1962.

REVIEW BY COUNTIES

The Commonwealth of Massachusetts, Department of Public Works, quarried basalt for its own use for concrete aggregate, roadstone, fill, and riprap in Bristol, Franklin, Hampden, Middlesex, Norfolk, and Plymouth Counties. Sand and gravel also was mined either by its crews or under contract by the State Department of Public Works in all counties except Dukes, Essex, Middlesex, Nantucket, Suffolk, and Worcester. Certain cities or towns also produced small quantities of sand and gravel for their own use in street and road maintenance; included were North Adams, Dartmouth, Lawrence, Amesbury, Malden, and Brockton.

TABLE 7.—Value of mineral production in Massachusetts, by counties

County	1962	1963	Minerals produced in 1963 in order of value
Barnstable	$198,201	268,045	Sand and gravel.
Berkshire	5,110,131	5,120,889	Lime, stone, sand and gravel.
Bristol	2,090,562	2,315,228	Sand and gravel, stone, clays.
Dukes	31,494	(1)	Sand and gravel.
Essex	2,416,764	2,601,104	Stone, sand and gravel, peat.
Franklin	722,898	823,231	Sand and gravel, stone.
Hampden	2,431,078	2,563,727	Stone, sand and gravel, clays.
Hampshire	1,036,189	485,986	Sand and gravel, stone.
Middlesex	8,908,876	10,549,346	Stone, sand and gravel.
Nantucket	6,580	(1)	Sand and gravel.
Norfolk	3,831,744	4,661,428	Sand and gravel, stone, clays.
Plymouth	714,547	913,515	Do.
Suffolk	437,177	385,292	Stone, sand and gravel.
Worcester	2,095,916	1,941,163	Sand and gravel, stone, peat.
Undistributed [2]	3,000	31,749	
Total	30,035,000	32,661,000	

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes gem stones unspecified by counties, and values indicated by footnote 1

Barnstable.—Concrete Products Co. of Cape Cod, Inc., Falmouth, mined sand and gravel for building and for fill. Frederick V. Lawrence, Inc., Falmouth, produced processed sand and gravel for construction and paving and bank-run gravel for fill. Falmouth Cement Works, Inc., Teaticket, sold unprepared sand for building purposes. One other producer sold paving sand and gravel. Whitehead Brothers Co. produced molding sand at Provincetown.

Berkshire.—Production of limestone and lime remained high in 1963, and output was confined to Berkshire County. The four operators who produced limestone were John S. Lane & Son, Inc., West Stockbridge; Lee Lime Corp., Lee (two quarries); New England Lime Co., Division of Chas. Pfizer & Co., Inc., Adams; and United States Gypsum Co., Farnams. The chief uses for limestone were concrete aggregate and roadstone, agricultural stone, lime manufacture, rubber and asphalt filler, mineral food, and blast-furnace flux. Lime, produced by the last three firms, was consumed mostly as building lime, for various chemical and industrial uses, and as agricultural lime (calcined). Otis Chester Granite Co., Otis, quarried and sold a small quantity of rough dimension granite.

Production of sand and gravel was less than in 1962. Eighty-three percent of the sand and gravel was sold or used as screened or otherwise prepared material. Twenty operators were active. General

Sand & Stone Corp. again was the leading producer. Other large producers included Berkshire Gravel, Inc., Pittsfield; Cairo Redi-Mix Corp., Great Barrington; Maxymillian, Inc., Adams; and W. E. Williams, Inc., Lenox Dale.

Bristol.—Output of sand and gravel increased 4 percent, and the county retained its rank of fifth largest producing county. Eighty-two percent of the commercial production was screened or washed material. Government-and-contractor tonnage comprised 23 percent of the total. Sales were chiefly for building, paving, and fill. Sixteen firms were active during the year. Among the leading producers were Assonet Sand & Gravel Co., Inc., Freetown; Morse Sand & Gravel Co., Attleboro; River Sand & Gravel Co., Inc., Pawtucket, R.I.; Pine Hill Sand and Gravel, North Dartmouth; and Joseph Borge & Sons, Inc., Swansea. Miscellaneous clay was mined for use in making building brick by Stiles & Hart Brick Co. at Taunton. Morse Sand & Gravel Co., Attleboro, and Warren Bros. Road Co., Acushnet, quarried basalt for concrete aggregate and roadstone.

Dukes.—Sand and gravel production decreased from 1962 levels. Output was used for building, paving, and fill. The chief operators were Goodale Construction Co., Inc., Vineyard Haven, and Grant Brothers, Inc., Edgartown.

Essex.—Trimount Bituminous Products Co., Saugus, and Lynn Sand & Stone Co., Swampscott, quarried basalt, mostly for concrete aggregate, railroad ballast, and riprap. Essex Bituminous Concrete Corp., Peabody, produced quartzite for concrete aggregate and roadstone. This material was erroneously classified as basalt in recent years. Providence Granite Co., Inc. (formerly operating as Rockport Quarries Co., Inc.), produced dimension granite at its Rockport quarry. Karl A. Persson also quarried dimension granite at Rockport for rubble and flagging.

Production of sand and gravel rose 26 percent, largely owing to increased road construction and active building operations. Over 70 percent of commercial sand and gravel was washed and screened. Producing plants totaled 15. The largest producer was Merrimack Materials, Inc., Groveland, producing building and paving sand and building gravel. Andover Sand & Gravel, Inc., Lawrence; Georgetown Sand & Gravel Co., Georgetown; and Essex Sand & Gravel Co., Inc., Andover, produced sizable tonnages for paving, building, fill, and ice control.

Andover Sand & Gravel, Inc., recovered peat humus from a bog near Lawrence for sale, both packaged and in bulk.

Franklin.—Franklin County rose to second place among sand and gravel producing counties. Production of nearly 2.7 million tons was due to the sharply increased output of Government-and-contractor tonnage used in road construction. Nearly 90 percent of the combined commercial and Government-and-contractor output was prepared material. The largest producers were Massachusetts Department of Public Works, Mackin Sand & Concrete Products, Greenfield; Northfield Washed Sand & Gravel Co., Inc., Northfield; and Warner Bros., Inc., Sunderland (Zmetra pit). Twelve other smaller producers mined sand and gravel, chiefly for paving and fill.

Basalt was quarried near Deerfield by Greenfield Mass., Broken

Stone Co. for use as riprap, railroad ballast, and concrete aggregate and roadstone.

Hampden.—John S. Lane & Sons, Westfield, quarried and crushed basalt for concrete aggregate and railroad ballast. The company's West Springfield quarry again was idle. McCormick Longmeadow Stone Co., Inc., East Longmeadow, sharply increased its output of dimension architectural sandstone.

Output of sand and gravel increased 19 percent, because of augmented production of fill and higher demand for paving. Twenty-two plants produced commercial sand and gravel. The principal commercial operators were John's Trucking Co., Agawam; North Wilbraham Sand & Gravel & Concrete Co., Inc., North Wilbraham; Monson Sand & Gravel Corp., Monson; and Berkshire Asphalt Co., Inc., Springfield. The chief uses were paving, building, fill, and ice control. A detailed description, including several photographs, of the sand and gravel plant of the Baxter Sand & Gravel Co., Southwick, and its operating procedures was published.[2]

Miscellaneous clay for use in manufacturing building brick was mined by Hampshire Brick Co., Willimansett, and Westfield Clay Products Co., Westfield.

Hampshire.—Production of commercial sand and gravel rose 25 percent, and over three-quarters was washed, screened, or otherwise prepared. Gravel comprised 58 percent of total sales. Bill Willard, Inc., Northampton; Donovan Brothers, Inc., Huntington; D. D. Ruxton Co., Inc., Amherst; and Omasta Brothers, Inc., Northampton, were the largest producers. Nine smaller operators also produced sand and gravel in the county. Output of Government-and-contractor tonnage declined drastically. John S. Lane & Sons, Inc., quarried basalt at Amherst for concrete aggregate and roadstone.

The Zonolite Co. exfoliated vermiculite at East Hampton for sale as lightweight aggregate and insulation.

Middlesex.—Middlesex was first among Massachusetts counties in output and value of both stone and sand and gravel. Dimension granite was quarried and sold by six operators in the Westfield-Chelmsford region. Two of these producers also sold crushed and broken material for riprap and other uses. Dimension stone producers were H. E. Fletcher, West Chelmsford (some crushed and broken also); Guilmette Bros. Corp., and LeMasurier Granite Quarry, Inc. (also some crushed and broken), both near North Chelmsford; and Forest Road Granite Co., Inc. (new in 1963), Oak Hill Granite Co., and Morris Bros. Granite Co., Inc., all near Westford. Dimension stone sold included rough construction stone, rubble, paving blocks, curbing, and architectural and monumental stone. Production of basalt increased over 30 percent, chiefly owing to greater highway construction activity. Output was consumed mostly for concrete aggregate, roadstone, and riprap. Producers included B. & M. Crushed Stone Corp., Ashland; J. B. Condon Corp., and George Brox., Inc., Dracut; Rowe Contracting Co., Malden; and Massachusetts Broken Stone Co., Weston.

[2] Herod, Buren C. Baxter Sand & Gravel—Young Massachusetts Firm Shows Mature Ability in Servicing Diversified Markets. Pit and Quarry, v. 56, No. 5, November 1963, pp. 134–136.

Production of commerical sand and gravel rose 49 percent, and totaled 29 percent of the total for the State. Over 60 percent of the output was gravel. Only 66 percent of the material sold was screened, washed, and otherwise prepared, compared with 88 percent in 1962. There were 35 active plants. The largest were Smith Brothers, Somerville; Acme Sand & Gravel Co., Inc., Woburn; Marshall Corp., Medford; Pomerleau Brothers, Inc., Westford; J. J. Cronin Co., North Reading; Burlington Sand & Gravel Co., Inc., Burlington; and San-Vel Contracting Co., Littleton. Production was chiefly sold for building, paving, and fill. A description of the operations of Stow Sand & Gravel, Inc., Boxboro, near South Acton, was published.[3]

The Zonolite Co., North Billerica, exfoliated domestic vermiculite for sale as lightweight aggregate and insulation.

Nantucket.—Nantucket Construction Co. produced mostly bank-run sand for fill near Nantucket.

Norfolk.—Output of sand and gravel increased 16 percent over that of 1962. Norfolk County ranked third among sand- and gravel-producing counties. Sand comprised about half of the commercial output. Most of the production was washed, screened, or otherwise prepared. Fifteen plants were active. The principal producers included West Sand & Gravel Co., Walpole; Wrentham Sand & Gravel Co., Inc., Wrentham; Highland Sand & Gravel Co., Inc., Dedham and Walpole; A. A. Will Sand & Gravel Corp., Canton; and Tresca Brothers Sand & Gravel Co., Millis. Production was chiefly for building, with most of the remainder for paving and fill.

Bates Bros. Seam Face Granite Co., Weymouth, and Antonio Roscitto & Sons, Inc., operating the J. S. Swingle quarry at Quincy, produced dimension granite for rough construction and architectural work and for use as monumental stone. Old Colony Crushed Stone Co., Quincy, and Simeone Stone Corp., Wrentham, produced crushed granite mostly for concrete aggregate, roadstone, and stone dust. Crushed basalt for similar uses also was quarried by Simeone Stone Corp., at Stoughton. S. M. Larusso & Sons, Inc., quarried miscellaneous stone (rhyolite) at Wrentham. This material was sold to Bird & Son, Inc., East Walpole, for manufacture into roofing granules at its Norwood plant.

Masslite, Inc., Plainville, continued to mine shale and converted it into lightweight aggregate which was sold for use in manufacturing building blocks and concrete. Output increased sharply over that of 1962.

California Products Corp., Vermiculite Division, Hingham, exfoliated South African vermiculite, mostly for use as concrete and plaster aggregate and for insulation. Although sales were greater than in 1962, adverse factors during 1963 included increased ocean freight rates and higher wages.

Plymouth.—Production of commercial sand and gravel increased moderately (7 percent). About 75 percent of the output was washed or screened, and 62 percent was sand. The leading producers included Marshfield Sand & Gravel, Inc., Marshfield; Petrino Sand & Gravel, Whitman; and Boston Sand & Gravel Co., Scituate. Whitehead

[3] New England Construction. Five-Year Plan--American Style. V. 28, No. 4, July 22, 1963, p. 40.

Bros. Co. produced molding sand near Marion. Sand and gravel also was mined by 23 other producers. The chief uses were for building and road construction.

Stiles & Hart Brick Co. continued manufacturing building brick, using its new beehive kiln installed in 1962. The production increase was due mostly to the more efficient operation of the new kiln. Plymouth Quarries, Inc., East Weymouth, produced rough architectural granite block and rubble for building purposes at its Hingham quarry. Southeastern Stone Co., Inc., producer of basalt, ceased production, and the company was dissolved.

Suffolk.—Crushed basalt for concrete aggregate and roadstone was produced near West Roxbury by West Roxbury Crushed Stone Co. Unprocessed gravel for paving was produced by one operator.

United States Gypsum Co., Charleston, manufactured calcined gypsum products from Nova Scotia gypsum. These products were marketed chiefly in the New England States.

Whittemore Products, Inc., Roslindale, expanded perlite for use as a lightweight aggregate in concrete and plasters, as a soil conditioner, and as insulating material.

Worcester.—Commercial output of sand and gravel was somewhat less than in 1962, and Worcester County dropped from second highest commercial production to sixth in 1963. Over 90 percent of the production was washed or screened, and 63 percent consisted of gravel. Leading producers included Rosenfeld Washed Sand & Stone Co., Milford; P. J. Keating Co., Lunenburg; Direnzo Brothers Sand & Gravel, Inc., Worcester; DeFalco Concrete Corp., Millbury; Worcester Sand & Gravel Co., Shrewsbury; Pine Tree Trusts, Whitinsville; and E. L. Dauphinais, Inc., North Grafton. There were 23 other smaller producers in the county. Sand and gravel was chiefly used for building and road construction, and gravel was chiefly used for fill.

Mario Pandolf Co., Inc., near Sterling, and Holden Trap Rock Co., Holden, quarried and crushed basalt for concrete aggregate and roadstone. Production of basalt increased. H. E. Fletcher quarried dressed architectural dimension granite at Milford. The Milford Pink dimension granite quarry of Castellucci & Sons, Inc., was idle during 1963.

Reed-sedge peat was mined by Sterling Peat Co., near Sterling Junction. Buth bulk and packaged sales were made.

The Mineral Industry of Michigan

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Michigan Department of Conservation, Geological Survey Division, State of Michigan, for collecting information on all minerals except fuels.

By Donald F. Klyce [1]

MINERAL production in Michigan was valued at $492 million, 10 percent more than in 1962, and an alltime high. Increased output of all major minerals, except petroleum, contributed to the record. Much of the increase was due to increased value of shipments of metallic ores (copper and iron). Building materials (cement, clays, gypsum, sand and gravel, and stone) also registered substantial gains. Petroleum output continued to fall as the prolific oil fields of the Albion-Pulaski-Scipio trend declined for the 2d consecutive year since their discovery in 1957. Iron ore was first in value, followed by cement, copper, petroleum, and sand and gravel. Nonmetals (construction materials and natural saline minerals) accounted for 56 percent of the State total, about the same proportion as in 1962. The value of metallic minerals increased to over 31 percent, while the remaining percentage represents the value of mineral fuels.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Employment and Injuries.—Nearly 37.7 million man-hours were worked in the Michigan mineral industries in 1963, excluding employees in the petroleum industry and officeworkers. This represented a 1-percent decrease from the 38.1 million man-hours recorded for 1962. Employment declines in the copper and iron ore industries were chiefly responsible for the decrease.

Ten fatalities, 3 each in the copper and iron ore industries, and 1 each in the coke oven, gypsum, limestone, and sand and gravel industries, occurred in 1963, compared with 11 in 1962. The total number of nonfatal disabling injuries decreased to 467 (preliminary figure), compared with the final figure of 545 for 1962.

---

[1] Industry economist, Bureau of Mines, Minneapolis, Minn.

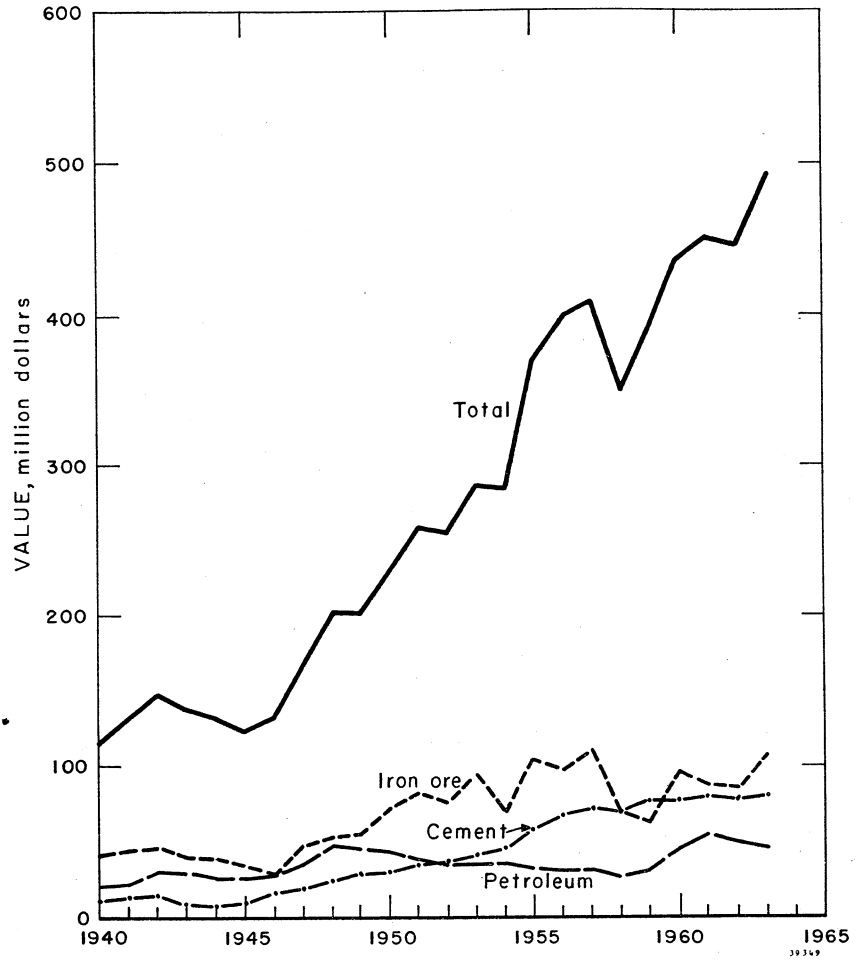


FIGURE 1.—Value of iron ore, petroleum, cement, and total value of mineral production in Michigan, 1940–63.

The Port Inland quarry, operated by the Inland Lime & Stone Co., won the Sentinels of Safety trophy, the top award, in the quarry group of the 1963 National Safety Competition. The quarry, located near Gulliver, worked 568,711 man-hours in 1963 without a disabling work injury. Other Michigan operations experienced injury-free records in 1963 and received Certificates of Achievement in Safety from the Federal Bureau of Mines.

Table 3 contains a summary of employment and injury data for selected State mineral industries. Certain industries are excluded from the table, primarily to avoid disclosing individual company confidential data.

TABLE 1.—Mineral production in Michigan [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	22,682	$73,267	25,016	$76,944
Masonry—thousand 280-pound barrels	1,517	4,335	1,684	4,519
Clays—thousand short tons	1,751	1,917	1,958	2,149
Copper (recoverable content of ores, etc.)—short tons	74,099	45,645	75,262	46,361
Gypsum—thousand short tons	1,278	4,791	1,315	4,938
Iron ore (usable)—thousand long tons, gross weight	9,422	85,597	10,789	107,201
Lime—thousand short tons	1,153	15,371	1,371	18,431
Magnesium compounds—short tons	(2)	(2)	266,740	23,062
Manganiferous ore (5 to 35 percent Mn) short tons, gross weight			152,957	(2)
Natural gas—million cubic feet	28,987	6,174	32,850	8,902
Peat—short tons	[4] 257,693	2,277	251,809	2,413
Petroleum (crude)—thousand 42-gallon barrels	17,114	48,775	[3] 15,973	[3] 45,523
Salt—thousand short tons	4,274	33,343	4,244	33,656
Sand and gravel [5]—do	47,563	42,029	50,458	43,433
Silver (recoverable content of ores, etc.)—troy ounces	401,491	436	338,997	434
Stone—thousand short tons	28,440	29,055	30,316	32,065
Value of items that cannot be disclosed: Bromine, calcium chloride and calcium-magnesium chloride, gem stones, iodine, natural gas liquids, potassium salts, and values indicated by footnote 2		53,500		42,001
Total		[4] 446,512		492,032

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Preliminary figure.
[4] Revised figure.
[5] Includes friable sandstone.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$308,067	1958	$352,461
1953	322,692	1959	383,787
1954	306,127	1960	431,205
1955	384,801	1961	444,141
1956	395,862	1962	440,025
1957	411,885	1963	480,908

Water.—To obtain valid data concerning water use by the mineral industries for 1962, the Bureau of Mines conducted a nationwide canvass in 1963 of virtually all mineral extractive and certain mineral processing industries. Cement plants, lime plants, operations using natural well brines, and other manufacturing type operations were excluded. Table 4 summarizes some of the data collected for the State. As used in the table, "new water" is that entering the plant as makeup water, and when added to the "recirculated water" the total used or required for processing is given. "Water discharged" is used water leaving the plant. "Water consumed" is that which leaves the plant as moisture combined or entrained in the product or lost by evaporation and no longer available for reuse in the vicinity of the plant.

In addition to water use in extracting and processing mineral commodities, indicated in table 4, a substantial amount of water was required by the petroleum industry for well drilling. In 1962 nearly

1.2 million 42-gallon barrels of waters were required for well drilling in Michigan. Of this amount, nearly 75 percent was fresh water, and the remainder was saline water.

Approximately 24 gallons of water were required per foot of well drilled.

TABLE 3.—Employment and injuries for selected mineral industries [1]

Year and industry	Average number of men working	Total man-hours	Total number of disabling injuries		Total number of days lost or charged	Injury frequency rate [2]	Injury severity rate [3]
			Fatal	Nonfatal			
1962:							
Cement [4]	1,403	3,666,084	1	10	6,378	3.00	1,740
Clays [5]	234	509,255		1	59	1.96	116
Coke ovens	365	2,785,015		14	(6)	5.03	(6)
Copper	1,931	4,660,447	3	113	21,835	24.89	4,685
Gypsum	305	465,838		1	243	2.15	522
Iron ore	3,795	7,097,688	4	216	33,582	31.00	4,731
Limekiln [7]	137	364,653		4	63	10.97	173
Limestone [8]	1,428	2,560,090	1	17	6,633	7.03	2,591
Marl	57	35,302					
Sand and gravel [9]	2,683	4,739,299	1	86	9,729	18.36	2,053
Sandstone	61	136,524		6	177	43.95	1,296
Smelters	257	623,317		3	20	4.81	32
1963: [10]							
Cement [4]	1,376	3,767,529		21	(6)	5.57	(6)
Clays [5]	225	510,993		5	(6)	9.78	(6)
Coke ovens	987	2,880,196	1	8	(6)	3.12	(6)
Copper	1,670	4,110,838	3	126	(6)	31.38	(6)
Gypsum	260	515,824	1	1	(6)	3.88	(6)
Iron ore	3,422	6,929,331	3	177	(6)	25.98	(6)
Limekiln [7]	162	445,489		2	(6)	4.49	(6)
Limestone [8]	1,314	2,566,428	1	14	(6)	5.84	(6)
Marl	57	45,080					
Sand and gravel [9]	2,654	4,569,822	1	60	(6)	13.35	(6)
Sandstone	75	161,479		3	(6)	18.58	(6)
Smelters	251	634,198		5	(6)	7.88	(6)

[1] Excludes officeworkers.
[2] Total number of injuries per million man-hours.
[3] Total number of days lost or charged per million man-hours.
[4] Includes cement plants and quarries or pits producing raw material used in manufacturing cement.
[5] Excludes pits producing clay used in manufacturing cement.
[6] Data not available.
[7] Includes quarries producing limestone used in manufacturing lime.
[8] Excludes quarries producing limestone used in manufacturing cement and lime.
[9] Excludes friable sandstone, which is included under "sandstone."
[10] Preliminary data.

TABLE 4.—Water statistics for selected mineral industries in 1962

(Million gallons)

Industry	New water	Water recirculated	Total water used	Water discharged	Water consumed
Copper	20,268	17,599	37,867	20,226	42
Iron ore	4,894	8,241	13,135	4,756	138
Sand and gravel	12,616	10,796	23,412	12,276	340
Stone	7,008		7,008	6,359	649
Other nonmetals	2,467		2,467	2,467	
Total	47,253	36,636	83,889	46,084	1,169

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of cement increased more than 10 percent and reached an alltime high. Average mill value per barrel continued the decline that began in 1962. Comparative values were: Portland cement—$3.08 in 1963, $3.23 in 1962; masonry cement—$2.68 in 1963, $2.86 in 1962. Portland cement was produced in nine plants in seven counties. At six of these plants masonry cement also was produced. Total capacity of the plants was 34 million barrels, the same as in 1962. Yearend stocks of portland cement at mills were 2.5 million barrels, 822,000 less than the beginning of 1963. About 56 percent of the cement shipped was used in the State. Principal out-of-State shipments were to Ohio, Illinois, Wisconsin, New York, Indiana, and Minnesota.

Ready-mixed concrete companies purchased 53 percent of the cement output, while the balance went principally to contractors, concrete product manufacturers, and building material dealers.

Raw materials used in the manufacture of cement included 5.8 million tons of limestone and 1.8 million tons of clay or shale, as well as sand, gypsum, mill scale, slag, iron ore, grinding aids, and air-entraining compounds.

TABLE 5.—Finished portland cement produced, shipped, and in stock

(Thousand 376-pound barrels and thousand dollars)

Year	Active plants	Production	Shipped from mills		Stocks at mills Dec. 31
			Quantity	Value	
1954–58 (average)	8	19,244	19,072	$58,306	1,844
1959	8	21,561	21,862	72,198	2,912
1960	9	20,971	21,187	73,082	3,023
1961	9	21,661	21,948	75,172	2,737
1962	9	23,070	22,682	73,267	[1] 3,354
1963	9	24,194	25,016	76,944	2,532

[1] Revised figure.

Nearly 547 million kilowatt-hours of electrical energy was used. The wet process was used at all plants except one that used the dry process.

Clays.—Miscellaneous clay and shale was mined in 10 counties at 14 pits. Eighty-four percent of the output was used in cement manufacture. The remainder was used in manufacturing lightweight aggregate, heavy clay products (sewer pipe, drain tile), and pottery. The greatest production was from pits in Alpena, Monroe, and Wayne Counties.

Gem Stones.—Agates, native-copper specimens, goethite, hematite specimens, thomsonite, and Petoskey stone (fossil coral) were collected. Most of the material was found in the northern peninsula, although collectors reported finding Petoskey stone in lower Michigan (Antrim, Cheboygan, and Lenawee Counties).

747-416—64——36

Gypsum.—Gypsum was produced from underground mines in Kent County and from quarries in Iosco County. The crude material was processed at plants in Grand Rapids, National City and Detroit, and in plants in other States. Wallboard, exterior sheathing, lath, and plaster were manufactured. A considerable amount of gypsum was sold for use as a portland-cement retarder. Output of gypsum was about 3 percent larger than in 1962.

Lime.—Lime production increased about 20 percent, both in volume and value from that of 1962. Most of the increase was due to larger demand from steel and chemical manufacturers. Data for regenerated lime (produced by papermills, water purification plants, and acetylene processors) are excluded from the State total value of production. Principal lime output came from Wayne County. Three-quarters of the lime manufactured was used by the producer, and 95 percent was consumed within the State. Principal uses for lime were in chemical and metallurgical applications, paper and sugar manufacture, and water treatment. Most of the lime manufactured was quicklime; a small amount was hydrated. Annual lime-burning capacity of the lime plants reporting was about 1.8 million tons.

Natural Salines.—Bromine, calcium chloride, calcium-magnesium chloride, iodine, magnesium compounds, and potash were extracted from natural well brines at plants in Gratiot, Lapeer, Mason, Manistee, and Midland Counties.

Dow Chemical Co. put on-stream a plant in Midland to produce ethyl bromide by the reaction of ethylene with hydrogen bromide in the presence of gamma radiation emitted from rods containing small aluminum-clad slugs of radioactive cobalt 60.[2] This is the first time that radiation energy was used as a catalyst in a commercial chemical reaction. The process is the result of several years of pilot plant studies in Dow laboratories.

Perlite.—Expanded perlite was produced at plants in Iosco and Kent Counties from crude ore mined in Colorado and Nevada. The material was used in building plaster. Both volume of shipments and value were less than in 1962. One manufacturer in Grand Rapids reported that he no longer processed the material.

Salt.—Salt was mined from an underground deposit in Detroit and processed from natural well brines and artificial brines in Gratiot, Manistee, Midland, Muskegon, St. Clair, and Wayne Counties. The principal uses for salt, were in chemical manufacture (chorline, soda ash), meatpacking, animal feed, water softening, and ice removal. Volume was slightly less than in 1962, but the distribution pattern changed considerably. Purchase by Government agencies and transit companies for ice control declined by nearly 15 percent. Increased use in chemical manufacture and food processing absorbed most of the loss.

Sand and Gravel.—Michigan sand and gravel output exceeded 50 million tons for the second time, and ranked second in the Nation in production and third in value. Sand and gravel production was reported from all counties except Monroe. The Detroit area accounted for 40 percent of the value and 36 percent of the State sand and gravel

[2] Dow Diamond. Winter Issue 1963. Published by the Dow Chemical Co., Midland, Mich., v. 26, No. 1, pp. 26–27.

production. Production exceeding 1 million tons was also reported from Allegan, Ingham, Kalamazoo, Kent, Ottawa, and Tuscola Counties.

Sand and gravel output increased by 6 percent over 1962. Larger requirements for paving material and fill accounted for much of the increase. More than 92 percent of the sand and gravel was processed or treated. Nearly 47 million tons of sand and gravel was transported by truck, and the remainder was moved by rail and water. Production was reported from 339 commercial operations and 262 Government-and-contactor operations.

TABLE 6.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand: [1]				
Molding	[2] 1,998	[2] $3,456	2,178	$3,896
Building	4,715	3,706	4,827	3,444
Paving	4,167	3,912	5,049	4,535
Fill	1,722	680	3,092	1,383
Undistributed [3]	[2] 708	[2] 1,700	721	1,707
Total	13,310	[4] 13,455	15,867	14,965
Gravel:				
Building	4,441	5,362	4,920	6,293
Paving	17,021	14,803	16,480	13,818
Railroad ballast	187	193	(5)	(5)
Fill	374	228	291	163
Other	[2] 214	258	438	423
Total	22,237	20,844	22,129	[4] 20,696
Total sand and gravel	35,547	34,299	37,996	[4] 35,662
Government-and-contractor operations:				
Sand:				
Paving	2,056	1,048	1,965	1,014
Fill	1,386	474	1,497	516
Other	86	35	143	71
Total	[4] 3,529	[4] 1,556	3,605	1,601
Gravel:				
Building	139	69	66	30
Paving	7,610	5,810	8,257	5,947
Fill	564	226	355	121
Other	175	68	179	72
Total	[4] 8,487	6,173	8,857	6,170
Total sand and gravel	12,016	[4] 7,730	12,462	7,771
All operations:				
Sand	16,839	[4] 15,012	19,472	[4] 16,567
Gravel	30,724	[4] 27,018	30,986	[4] 26,867
Grand total	47,563	[4] 42,029	50,458	[4] 43,433

[1] Includes friable sandstone.
[2] Revised figure.
[3] Includes blast, glass, engine, foundry, grinding and polishing and other construction and industrial sands.
[4] Data do not add to total shown because of rounding.
[5] Figure withheld to avoid disclosing individual company confidential data; included with "Other."

The 10 leading producers of sand and gravel, in alphabetical order, were:

American Aggregates Corp.
Construction Aggregates Corp.
O. E. Gooding & Co.
Grand Rapids Gravel Co.
Holloway Sand & Gravel Co., Inc.
Holly Sand & Gravel Division.
Michigan Silica Co.
Pickitt & Schreur, Inc.
Sargent Sand Co.
I. L. Whitehead Co.

Stone.—Basalt, marl, limestone, and sandstone were produced. Nearly all (99 percent) of the material was limestone, quarried in 15 counties by 20 commercial producers and 4 county highway agencies. A very large proportion of the limestone was quarried and crushed in a few very large quarries in Alpena, Chippewa, Mackinac, Monroe, and Presque Isle Counties. Nearly 24 million tons of stone was moved by water from company-operated ports on Lakes Huron and Michigan to steel mills, cement and lime plants, and other industrial consumers. Shipments were nearly 7 percent larger than in 1962 due to larger demand from steel mills, cement plants, other industrial users, and roadbuilders. Of the 30.1 million tons of crushed limestone produced, 11.1 million tons was used for flux; 14.5 million for cement, lime, and other industrial uses; and 3.9 million for roadstone and concrete aggregate. The largest producers of limestone, in alphabetical order, were:

Dummond Dolomite, Inc. (Chippewa County).
Dundee Cement Co. (Monroe County).
The France Stone Co. (Monroe County).
Huron Portland Cement Co. (Alpena County).
Inland Lime & Stone Co. (Mackinac County).
Michigan Stone Co. (Monroe County).
Penn-Dixie Cement Corp. (Emmet County).
Presque Isle Corp. (Presque Isle County).
United States Steel Corp. (Mackinac and Presque Isle Counties).
The Wallace Stone Co. (Huron County).

TABLE 7.—Dimension stone sold or used by producers, by kinds

Year	Limestone		Sandstone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1959	6,503	$58,120	21,779	$154,510	28,282	$212,630
1960	6,801	58,889	11,615	97,395	18,416	156,284
1961	27,516	119,950	7,045	54,057	34,561	174,007
1962	7,798	51,603	15,223	65,406	23,021	117,009
1963	4,938	60,371	8,937	62,348	13,875	122,719

Basalt was quarried for road use by the Houghton County Road Commission. Marl was produced in 15 counties at 34 operations. The largest output was reported from Allegan, Barry, Calhoun, Cass, and Kalamazoo Counties.

Sandstone, principally for building use, was quarried and milled in Baraga and Jackson Counties. The Alcona County Road Commission quarried and crushed sandstone for road use.

TABLE 8.—Crushed and broken stone sold or used by producers, by kinds and uses

(Thousand short tons and thousand dollars)

Kind and use	1962		1963	
	Quantity	Value	Quantity	Value
Basalt: Concrete aggregate and roadstone	73	$73	15	$15
Limestone:				
Flux	10,513	11,069	11,194	12,785
Concrete aggregate and roadstone	3,730	4,609	3,860	4,616
Agriculture	485	801	484	838
Cement	7,834	6,255	8,157	6,455
Lime	2,572	2,327	2,387	2,128
Other [1]	3,054	3,701	4,029	4,987
Total	[2] 28,187	[2] 28,763	[2] 30,110	31,809
Marl: Agriculture	146	88	169	109
Sandstone:				
Riprap	10	12	(3)	(4)
Concrete aggregate and roadstone			7	9
Other [5]	1	1	(3)	(4)
Total	11	13	[2] 8	9
Grand total	28,417	[2] 28,938	30,302	31,942

[1] Includes limestone for whiting or whiting substitutes (1962), miscellaneous filler and stone sand (1963), riprap, railroad ballast, asphalt filler, dust for coal mines, mineral food, poultry grit, chemical and other uses.
[2] Data do not add to total shown because of rounding.
[3] Less than 500 short tons.
[4] Less than $500.
[5] Includes sandstone for fill (1962), and foundry.

Sulfur.—Byproduct sulfur was recovered from crude petroleum in Detroit by the Marathon Oil Co., using the Parsons process. At Alma, Leonard Refineries, Inc., used the hyrofining process to recover sulfur.

Vermiculite.—Crude vermiculite, produced in Montana and South Carolina, was exfoliated at the Dearborn plant of Zonolite Division, W. R. Grace & Co.

METALS

Metals accounted for over 31 percent of the total value of mineral production, up from 29 percent in 1962.

Copper.—Production of copper in terms of recoverable metal was 2 percent larger than in 1962. The value of output increased in the same proportion, as the price remained stable throughout the year.

Copper producers operated throughout the year without interruption. Output was reported from 10 underground mines and 3 tailing reclamation plants.

Calumet & Hecla, Inc., operated seven mines, one reclamation plant, and one smelter in Houghton and Keweenaw Counties. Copper Range Co. operated the Champion mine and the Freda mill in Houghton County. The mill concentrated ore from the mine and tailings from the Redridge and Atlantic mill sands. As the company White Pine smelter was taxed to capacity throughout 1963, the Freda mill concentrates were refined at the Calumet & Hecla, Inc., smelter at Hubbell. White Pine Copper Co., a wholly owned subsidiary of Copper Range Co., operated two mines, a mill, and a smelter in Ontonagon

County. Quincy Mining Co. operated a tailing reclamation plant and smelter in Houghton County.

TABLE 9.—Mine production of copper in 1963, by months, in terms of recoverable metal

Month	Short tons	Month	Short tons
January	6,460	August	5,975
February	5,845	September	5,735
March	6,495	October	6,405
April	6,480	November	6,305
May	6,920	December	6,422
June	6,460		
July	5,760	Total	75,262

TABLE 10.—Mine production of copper, in terms of recoverable metal

Year	Mines producing		Material treated		Copper	
	Lode	Tailing	Ore (short tons)	Tailing (short tons)	Short tons	Value
1954–58 (average)	12	2	5,224,358	1,848,154	50,318	$33,846,727
1959	10	3	5,666,533	1,940,455	55,300	33,954,200
1960	9	3	5,600,290	2,192,818	56,385	36,199,170
1961	10	3	7,109,924	2,122,286	70,245	42,147,000
1962	9	3	7,555,357	1,812,530	74,099	45,644,984
1963	10	3	7,211,387	2,226,129	75,262	46,361,392

The average weighted price of copper was 30.8 cents per pound, the same as in 1962. The price quoted by primary producers for delivered electrolytic copper at the beginning of 1963 was 31 cents per pound and remained at that price throughout the year.

Iron Ore.—Shipments of iron ore from Michigan mines increased 1,368,000 tons over that of 1962, nearly 15 percent. The value of shipments increased by 25 percent because of a larger proportion of jaspilite concentrate and pellets. Concentrate produced from jaspilite accounted for more than 43 percent of iron ore shipments and 54 percent of value of shipments in 1963. A total of 15 underground and 5 open-pit mines were active all or part of the year, 4 fewer underground mines than were operated in 1962.

More than 64 percent of the ore mined came from open-pit operations, compared with 50 percent in 1962. Average iron content of usable ore produced was 57.21 percent natural. The average weighted mine value of Michigan iron ore, without respect to grade, was $9.94, compared with $9.08 per long ton in 1962. Vessel freight rates to lower Lake ports were reduced 10 cents per ton in August. This reduction did not change the mine value, as the freight saving was passed on to the buyer.

Michigan iron ore was shipped to producers of pig iron and steel except for a small quantity used in manufacturing iron oxide pigments. About 97 percent of the iron ore was shipped by rail to ore docks in Ashland, Wis., and Escanaba and Marquette, Mich., and then by boats to lower Lake ports. The balance was all-rail shipments to consuming districts. The lake shipping season for Michigan ores opened at Escanaba on April 19 and closed at the same port on December 16.

TABLE 11.—Crude iron ore[1] data, in 1963, by counties and ranges

(Thousand long tons)

County and range	Stocks of crude ore Jan. 1	Production		Shipments		Stocks of crude ore Dec. 31
		Underground	Open pit	Direct to consumers	To beneficiation plants	
County:						
Dickinson			2,536		2,536	
Gogebic	548	902		813		637
Iron	931	2,814		3,067		678
Marquette	2,387	2,199	8,068	972	9,306	2,375
Total[2]	3,865	5,914	10,604	4,852	11,842	3,689
Range:						
Gogebic	548	902		813		637
Marquette	2,387	2,199	8,068	972	9,306	2,375
Menominee	931	2,814	2,536	3,067	2,536	678
Total[2]	3,865	5,914	10,604	4,852	11,842	3,689

[1] Exclusive of iron ore containing 5 percent or more manganese, natural.
[2] Data do not add to totals shown because of rounding.

TABLE 12.—Usable iron ore shipped from mines, by ranges[1]

(Thousand long tons)

Year	Marquette range	Menominee range (Michigan part)	Gogebic range (Michigan part)	Total
1954–58 (average)	5,144	3,833	2,548	11,525
1959	3,530	2,469	1,249	7,247
1960	4,881	4,018	1,892	10,792
1961	4,141	3,881	1,362	9,384
1962	4,479	3,462	1,480	9,422
1963	5,809	4,168	813	10,789

[1] Exclusive of iron ore containing 5 percent or more manganese, natural.

TABLE 13.—Usable iron ore produced, by ranges[1]

(Thousand long tons)

Year	Marquette range	Menominee range (Michigan part)	Gogebic range (Michigan part)	Total
1954–58 (average)	5,324	3,804	2,499	11,627
1959	2,851	2,616	1,663	7,129
1960	6,619	4,079	2,169	12,866
1961	3,205	4,097	1,062	8,364
1962	4,563	3,460	1,237	9,259
1963	5,706	3,729	902	10,336
Total 1854–1963	322,909	[2] 265,963	[2] 247,484	836,355

[1] Exclusive of iron ore containing 5 percent or more manganese, natural.
[2] Distribution by range partly estimated before 1906.

At yearend, estimated reserves of iron ores in Michigan totaled 83 million long tons,[3] not including about 1.8 billion tons of low-grade hematite ore.

Manganiferous Ore.—Manganiferous ore (containing 5 to 35 percent manganese, natural) was shipped from the stockpile at the Cannon mine. The mine was closed in September 1962 and manganiferous ore had not been mined since 1961.

TABLE 14.—Manganiferous iron ore (containing 5 to 10 percent manganese, natural) and ferruginous manganese ore (containing 10 to 35 percent manganese, natural) shipped from mines

Year	Long tons	Year	Long tons
1954–58 (average)	44,901	1961	15,253
1959		1962	
1960	161,125	1963	136,569

Pig Iron and Steel.—Pig iron and steel were manufactured in the Detroit area. Pig iron shipments increased 22 percent in volume and 19 percent in value over 1962. Basic and bessemer grades were produced. According to the American Iron & Steel Institute, Michigan steel production was more than 8.4 million tons, about 18 percent higher than in 1962.

Silver.—Silver was recovered from copper ore mined at the White Pine mine. High silver-bearing concentrate from a silver-recovery circuit in the White Pine mill was smelted separately for delivery to electrolytic refineries where the silver was recovered.

MINERAL FUELS

Natural Gas and Natural Gas Products.—About 56 percent of the State gas production came from oil well gas; the remainder, from gasfields. About 43 percent of the gas came from gas and oilfields in St. Clair County. Another 30 percent came from the fields of the Albion-Pulaski-Scipio Trend in Calhoun, Hillsdale, and Jackson Counties. Other major gas-producing areas were in Macomb, Missaukee, and Roscommon Counties. The above areas yielded 85 percent of the State total. The remainder came from fields in 22 counties. Seven new gasfields opened in 1963, increasing the producible dry gasfields to 80.

Production of both natural gasoline and liquefied petroleum gases increased substantially over that of 1962. The value of natural gas products was one-third higher than in the previous year. Extraction of LP gas products from wet gas processing was centered in Albion-Pulaski-Scipio Trend and Belle River Mills fields where nearly 75 percent of the total was produced. The increase was partially due to extraction of residual LP gas from gas delivered via interstate pipeline from Southwestern States. Extraction from interstate pipeline gas began at the Willow Run plant in December 1963.

Peat.—Peat production was down 2 percent from 1962, while the value increased by 6 percent. Michigan was the leading peat-producing State with 46 percent of the national output.

[3] Geological Survey Division, Michigan Department of Conservation. General Statistics Covering Costs and Production of Michigan Iron Mines. June 1964, 15 pp.

Peat was produced in 15 counties, with 96 percent coming from Lapeer, Oakland, Sanilac, and St. Clair Counties. Peat was marketed principally as a soil conditioner. None was sold for fuel.

Petroleum.—Decline in petroleum production, which began in 1962, continued, and output dropped more than 1.1 million barrels. More than half the loss was sustained in the Albion-Pulaski-Scipio-Trend fields, which accounted for 58 percent of State production.

According to data published in the Annual Statistical Summary of Michigan's Oil and Gas Fields, 1963, by the Geological Survey, Michigan Department of Conservation, no significant new oil reserves were found in 1963. Leasing activities dropped off sharply from previous years.

In 1963, a total of 1.8 million acres under lease at yearend was reported by 24 companies, compared with 3.6 million acres by 26 companies at the end of 1962. A decrease in the number of acres of State mineral lands under lease also was reported.

Geophysical exploration continued at about the same level as in 1962. Much of the geophysical surveying was done in the eastern and northern parts of the State. Most discoveries (Niagaran reefs) in eastern Michigan were found by gravimeter, or gravimeter and subsurface study. New oilfield discoveries during 1963 increased the active oilfields to 179. In addition, three new pools or pays were added to older fields. There were seven fields or pools abandoned during the year. New well completions, including reworks and wells deepened to new pay zones, increased the yearend total of producible wells to 4,598.

In 1963, 48 percent of the exploratory wells were completed in the Silurian or Ordovician formations. Emphasis in exploration seemed to be on locating structural traps rather than reefs or fracture reservoirs.

Petroleum was produced in 44 counties all in the lower peninsula. Fourteen operating crude oil refineries had a crude-oil refining capacity of 172,739 barrels daily as of January 1, 1963.

Fluid injection was used in producing about 3.7 million barrels of petroleum and nearly 3 billion cubic feet of gas. More than 46 million barrels of fluid, mostly brines, were injected into producing formations through 282 wells. From the same fields, more than 47 million barrels of fluid, nearly all brine, was produced.

REVIEW BY COUNTIES

Mineral production was reported from all counties in Michigan. The value of output increased in 46 counties and decreased in 37 counties. Output exceeded $1 million in 44 counties. Marquette County led in value of production.

Allegan.—Natural gas, peat, petroleum, sand and gravel, and marl were produced. More than 1.5 million tons of sand and gravel were mined by several commercial operators and the county road commission. Marl for agricultural use was dug at three sites. Natural gas production continued to decline and was 38 percent of the 1.6-billion-cubic-feet output in 1962. Petroleum production of 262,000 barrels was slightly more than in 1962. A small quantity of peat was dug from a bog near Wayland.

Alpena.—Portland and masonry cements were manufactured in Alpena by Huron Portland Cement Co. An automated loading system to reduce shiploading time at the largest cement plant in the world was installed. Bulk loading of lake steamers is accomplished in 3 hours, compared with 8 hours for the former system. Sand and gravel for road use and clay and limestone for cement were also produced in the Alpena area.

TABLE 15.—Value of mineral production in Michigan, by counties [1]

County	1962	1963	Minerals produced in 1963 in order of value
Alcona	$155,617	$158,935	Sand and gravel, stone.
Alger	66,532	54,253	Sand and gravel.
Allegan	1,518,347	[2] 1,860,432	Sand and gravel, petroleum, peat, stone, natural gas.
Alpena	[3]	[3]	Cement, stone, clays, sand and gravel.
Antrim	263,008	204,664	Clays, sand and gravel.
Arenac	1,340,990	1,315,214	Petroleum, stone, sand and gravel.
Baraga	373,653	242,320	Sand and gravel, stone.
Barry	411,811	406,172	Sand and gravel, petroleum, stone, peat.
Bay	[3]	7,585,143	Cement, petroleum, lime, sand and gravel.
Benzie	32,418	139,901	Sand and gravel.
Berrien	1,044,180	567,968	Sand and gravel, stone.
Branch	184,461	94,622	Do.
Calhoun	10,017,935	[2] 8,081,390	Petroleum, sand and gravel, stone, natural gas.
Cass	419,957	370,244	Sand and gravel, petroleum, stone.
Charlevoix	47,568	23,469	Sand and gravel.
Cheboygan	219,351	246,165	Sand and gravel, stone.
Chippewa	4,642,069	4,236,858	Stone, lime, sand and gravel.
Clare	1,409,580	[2] 1,579,679	Petroleum, sand and gravel, natural gas.
Clinton	452,518	269,239	Sand and gravel, clays, peat.
Crawford	417,820	[2] 417,593	Petroleum, sand and gravel, natural gas.
Delta	287,604	195,834	Sand and gravel, stone.
Dickinson	4,189,933	12,252,971	Iron ore, sand and gravel, stone.
Eaton	490,978	548,814	Sand and gravel, stone, clays, peat.
Emmet	9,990,220	9,810,176	Cement, stone, sand and gravel.
Genesee	634,346	746,675	Sand and gravel, petroleum.
Gladwin	1,245,354	1,248,025	Petroleum, sand and gravel.
Gogebic	12,199,452	6,696,225	Iron ore, sand and gravel.
Grand Traverse	[3]	84,226	Sand and gravel.
Gratiot	[3]	[3]	Salines, salt, petroleum, sand and gravel, natural gas.
Hillsdale	11,576,534	[2] 12,773,619	Petroleum, sand and gravel, stone, natural gas.
Houghton [4]	46,494,436	47,586,022	Copper, sand and gravel, stone.
Huron	995,810	1,046,163	Stone, sand and gravel, lime, petroleum.
Ingham	995,837	1,005,097	Sand and gravel, peat.
Ionia	530,058	217,362	Sand and gravel, petroleum.
Iosco	[3]	4,349,206	Gypsum, sand and gravel.
Iron	[3]	24,451,943	Iron ore, manganiferous ore, sand and gravel.
Isabella	1,914,020	[2] 1,467,209	Petroleum, sand and gravel, stone, natural gas.
Jackson	7,976,510	[2] 6,999,256	Do.
Kalamazoo	1,187,671	1,184,488	Sand and gravel, stone, peat.
Kalkaska	263,448	[2] 68,245	Petroleum, sand and gravel, natural gas.
Kent	2,802,534	[2] 3,945,931	Sand and gravel, gypsum, petroleum, peat, natural gas.
Keweenaw	[5]	[5]	Copper, sand and gravel.
Lake	[3]	56,098	Sand and gravel, petroleum.
Lapeer	1,239,625	1,287,262	Peat, sand and gravel, salines, petroleum.
Leelanau	66,978	100,828	Sand and gravel.
Lenawee	1,915,866	1,154,032	Cement, sand and gravel, clays, petroleum, peat.
Livingston	3,674,134	[2] 2,901,954	Sand and gravel, natural gas.
Luce	14,420	50,220	Sand and gravel.
Mackinac	[3]	[3]	Stone, sand and gravel.
Macomb	935,991	[2] 2,657,366	Sand and gravel, petroleum, natural gas.
Manistee	13,760,826	16,507,558	Salines, salt, sand and gravel.
Marquette	[3]	[3]	Iron ore, sand and gravel.
Mason	[3]	[3]	Salines, lime, petroleum, sand and gravel, natural gas.
Mecosta	209,192	[2] 190,627	Sand and gravel, petroleum, stone, natural gas.
Menominee	824,964	673,832	Lime, sand and gravel.
Midland	[3]	[3]	Salines, salt, petroleum, sand and gravel, natural gas.
Missaukee	1,883,808	[2] 1,466,781	Petroleum, sand and gravel, natural gas.
Monroe	[3]	[3]	Cement, stone, clays, petroleum, peat.
Montcalm	1,481,155	[2] 1,119,196	Petroleum, sand and gravel, peat, natural gas.

See footnotes at end of table.

TABLE 15.—Value of mineral production in Michigan, by counties [1]—Continued

County	1962	1963	Minerals produced in 1963 in order of value
Montmorency	(3)	$97,888	Sand and gravel, petroleum.
Muskegon	$1,785,779	[2] 2,077,078	Sand and gravel, salt, petroleum, natural gas.
Newaygo	225,151	[2] 227,599	Sand and gravel, petroleum, stone, natural gas.
Oakland	6,181,348	[2] 6,839,509	Sand and gravel, peat, petroleum, natural gas.
Oceana	898,659	[2] 1,236,000	Petroleum, sand and gravel, natural gas.
Ogemaw	1,190,998	[2] 1,091,672	Do.
Ontonagon	(5)	(5)	Copper, silver, sand and gravel.
Osceola	1,257,386	[2] 985,614	Petroleum, sand and gravel, stone, natural gas.
Oscoda	25,789	53,148	Sand and gravel, petroleum.
Otsego	39,982	[2] 29,714	Sand and gravel, natural gas.
Ottawa	2,141,762	[2] 2,567,226	Sand and gravel, petroleum, stone, natural gas.
Presque Isle	(3)	(3)	Stone, sand and gravel.
Roscommon	761,597	[2] 667,528	Petroleum, sand and gravel, natural gas.
Saginaw	387,524	452,054	Clays, petroleum, lime, sand and gravel.
St. Clair	16,330,653	[2] 16,486,562	Salt, petroleum, cement, peat, sand and gravel, clays, natural gas.
St. Joseph	215,158	(3)	Sand and gravel, stone, peat.
Sanilac	1,105,411	966,130	Peat, sand and gravel, lime.
Schoolcraft	146,662	95,981	Sand and gravel.
Shiawassee	302,044	369,228	Sand and gravel, clays.
Tuscola	1,895,629	2,003,801	Sand and gravel, petroleum, lime.
Van Buren	371,753	355,564	Sand and gravel, petroleum.
Washtenaw	1,267,648	[2] 1,332,645	Sand and gravel, petroleum, natural gas.
Wayne	39,834,025	[2] 41,805,111	Lime, cement, salt, sand and gravel, clays, stone petroleum, natural gas.
Wexford	79,948	59,275	Sand and gravel.
Undistributed [6]	[7] 217,266,613	219,535,171	
Total	[7] 446,512,000	492,032,000	

[1] Natural gas liquids not listed by counties as data are not available, included with "Undistributed."
[2] Excludes value of natural gas.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Includes value of mineral production in Keweenaw and Ontonagon Counties.
[5] Value of mineral production is included in that of Houghton County.
[6] Includes some petroleum (1963) and some sand and gravel not assigned to specific counties, and values indicated by footnotes 1, 2, and 3.
[7] Revised figure.

Antrim.—Shale was mined by Penn-Dixie Cement Corp. for use at the Petoskey plant. Road materials were produced for the county and State road departments.

Arenac.—Sand and gravel for building and road use were produced near Standish and Twining. The county road commission quarried and crushed stone for its own use. The Deep River, Standish, and Sterling fields produced the major part of the petroleum output.

Baraga.—Sandstone for building use was quarried at Arnheim by Superior Natural Red Stone Quarry. The Fox Valley Construction Co. operated sand and gravel pits at Baraga, L'Anse, and Michigamme and produced road materials. The county and State highway departments also obtained materials for their own use from pits throughout the county.

Barry.—Marl was dipped from deposits near Caledonia and Nashville and was sold for agricultural use. Pits throughout the county yielded sand and gravel for road use, building, fill, and ice control. Small quantities of peat and petroleum also were produced in the county.

Bay.—Aetna Portland Cement Co. Division, Martin Marietta Corp., produced portland and masonry cements at Bay City. Monitor Sugar Division of the Robert Gage Coal Co. produced lime for its own use in sugar refining. The Essexville and Kawkawlin fields yielded most of the petroleum produced in the county. Bay Refining

Co. refined crude oil at Bay City. The county and State road departments obtained gravel for road use.

Berrien.—Molding and blast sand and material for building and road use were produced at several sites in the county. Output exceeded 400,000 tons. Marl was obtained from pits near Three Oaks and sold for agricultural use.

Branch.—Sand and gravel for building, paving, and fill was produced at fixed plants in the Coldwater area and at portable plants throughout the county. Frisbie Bros. of Colon dipped marl from a lake and sold it for agricultural use.

Calhoun.—The county maintained second place in petroleum production, although output dropped 600,000 barrels. Natural gas production increased from 3.6 to 4 billion cubic feet. Over 200,000 tons of sand and gravel, mostly for building and road use, was produced at fixed plants at Battle Creek and Tekonsha and at several portable plants throughout the county. Pits near Burlington and Union City yielded marl for agricultural use.

Cass.—Petroleum production from the Jefferson field declined to 15,000 barrels from 42,000 in 1962. Six wells were drilled during the year, resulting in two producers and four dry holes. Fixed plants at Dowagiac and portable plants throughout the county, processed several hundred thousand tons of sand and gravel for building and road use. Marl was produced at several pits near Cassopolis, Dowagiac, Edwardsburg, and Jones.

Charlevoix.—The Charlevoix Lime & Stone Co. closed its operation near Charlevoix and moved to a quarry in Cheboygan County. Sand and gravel was produced with portable plants at several sites in the county for road and building purposes.

Cheboygan.—Afton Stone & Lime Co. quarried limestone near Afton for road use. Charlevoix Lime & Stone Co. operated the Campbell quarry near Afton and produced limestone for flux and agricultural use. A quarter million tons of sand and gravel, mostly for road use, was produced.

Chippewa.—Drummond Dolomite, Inc., operated a quarry and crushing plant on Drummond Island in Lake Huron and produced fluxstone, agricultural limestone, and road material. Over 700,000 tons of sand and gravel was produced with portable plants throughout the county. Most of the material was used in road construction.

Clare.—Over half a million barrels of petroleum was produced, about 40,000 barrels more than in 1962. Gas production dropped sharply from 507 million to 198 million cubic feet. Most of the oil and gas came from the Hamilton and Headquarters fields. Road and fill materials were obtained from several sand and gravel pits for the county and State highway departments.

Clinton.—Clay was mined near Grand Ledge and used in the manufacture of sewer pipe by Grand Ledge Clay Product Co. and American Vitrified Products Co. About 300,000 tons of sand and gravel was produced, mostly for paving and building use. Gillette Sand & Gravel, formerly of De Witt, moved its sand and gravel operation to Shiawassee County. Al-Par Peat Co., Ovid, produced peat for horticultural use.

Crawford.—Beaver Creek field yielded both petroleum and natural gas. Production was down about 10 percent from 1962. The county and State highway departments produced and purchased sand and gravel for road construction and maintenance.

Delta.—Bichler Bros., Escanaba, quarried and crushed limestone for concrete aggregate and roadstone and produced sand and gravel for building and paving use. Road gravel was produced with portable plants at several other sites in the county.

Dickinson.—The Hanna Mining Co. operated the Groveland open-pit iron mine and concentrator near Randville. In March, the company began operation of its new pelletizing plant. The plant has an annual capacity of 1.25 million tons of pellets. Felch Quarry Co. Division, North Range Mining Co., operated the Felch quarry and produced limestone for roofing granules and ornamental aggregate. Superior Rock Products Co. operated the Randville Quarry and produced limestone used for terrazzo and ornamental concrete. Sand and gravel was produced for building and road use.

Eaton.—Grand Ledge Clay Product Co. manufactured sewer pipe from clay mined near Grand Ledge. Cheney Limestone Co. operated a quarry near Bellevue and produced agricultural limestone, roadstone, and a small quantity of rubble. Sand and gravel was produced throughout the county, mostly with portable plants. Most of the material was used for road construction and maintenance. Hilu Peat Co. produced humus peat near Charlotte.

Emmet.—Penn-Dixie Cement Corp. produced masonry and portland cements at Petoskey. Late in 1963 the company announced plans for an extensive modernization program which will include a large kiln as well as installation of grinding, coal-handling, and auxiliary equipment. Completion is set for 1965. Limestone was quarried near the plant for use in making cement. The county road commission produced sand and gravel for its own use.

Genesee.—The Otisville field yielded a small quantity (2,423 barrels) of petroleum. More than 900,000 tons of sand and gravel was produced from pits throughout the county. Most of it was used for building, paving, and fill.

Gladwin.—Petroleum production (431,000 barrels) was about the same as in 1962. Most of the output came from the North Buckeye field. The Butman field was abandoned in 1963 after producing a quarter million barrels since 1949. Also abandoned was the Grant field with a cumulative production of 760,000 barrels. Gravel for road use was mined in the county.

Gogebic.—Pickands Mather & Co. operated the Geneva and Peterson mines. Sand and gravel production dropped to 200,000 tons from 354,000 in 1962. Nearly all of the material was used for road maintenance and construction.

Gratiot.—Michigan Chemical Corp. produced bromine, calcium-magnesium chloride, magnesium compounds, and salt from natural well brines at St. Louis. At Alma crude oil was refined at Leonard Refineries, Inc., and byproduct sulfur was recovered by hydrofining process. About 71,000 barrels of petroleum was produced from the Sumner field. North Star field produced a small amount of natural

gas. Sand and gravel, for building and paving, was produced by four operators.

Hillsdale.—The county again was the leading petroleum producer in the State, having an output of nearly 4.3 million barrels. Nearly 3.5 billion cubic feet of natural gas was produced. During the year 105 wells were drilled of which 39 were producing oil wells and 66 were dry holes. Pits near Allen and Mosherville yielded marl for soil conditioning. More than 600,000 tons of sand and gravel were mined for building, paving, and fill.

Houghton.—Copper was produced by Calumet & Hecla, Inc., Copper Range Co., and Quincy Mining Co. Calumet & Hecla operated the Allouez No. 3, No. 4 Ahmeek Peninsula, Centennial No. 2, Centennial No. 3, Kingston, Osceola No. 13, and Seneca. Ore from the waste rock stockpile of the Ahmeek Peninsula was also processed. Development of the Kingston conglomerate lode continued during the year. Copper Range Co. operated the Champion mine throughout the year. Ore from the Champion and tailings from the Atlantic and Redridge sands were treated at the Freda mill. Quincy Mining Co. operated a reclamation plant at Hubbell and a smelter at Hancock. The smelter was kept in operation during the year with several short shutdowns because production at the reclamation plant was not sufficient to keep the smelter going full time. The Limestone Mountain Co. operated a quarry at Pelkie and produced agricultural limestone. The county road commission quarried basalt for road use. Sand and gravel for building and paving was mined at several sites.

Huron.—Michigan Sugar Co. produced hydrated lime for its own use in sugar refining at Sebewaing. At Bay Port, The Wallace Stone Co. quarried and milled rough construction stone and crushed stone for railroad ballast, roadstone, and agricultural limestone. Some broken stone was sold for riprap. Sand and gravel for building, paving, and fill was produced at several sites. A small quantity of petroleum was produced from the Dwight and Grant fields.

Ingham.—Peat was produced from a bog near Delhi by Winn's Peat Corp. of Lansing. About 1 million tons of sand and gravel was produced, most of it for road construction and maintenance, building, and fill. The Lansing Board of Water & Light recovered lime from calcium carbonate precipitated in its water purification process.

Iosco.—Gypsum was quarried at Tawas City and processed at a plant at National City by National Gypsum Co. At this plant also, crude perlite, mined in Colorado, was expanded for use in plaster. United States Gypsum Co. operated a gypsum quarry at Alabaster. The company manufactured gypsum products at plants in Detroit and Grand Rapids. Road material and sandfill were produced at several sites. Michigan Gypsum Co. operated a quarry near Turner. The crude gypsum was sold as a cement retarder.

Iron.—The Hanna Mining Co. mined and shipped iron ore from the Hiawatha, Homer, and Wauseca mines and shipped from the stockpile at the closed Cannon mine. Manganiferous ore also was shipped from the Cannon stockpile. Inland Steel Co. operated the Bristol and Sherwood mines. At the Bristol a larger compressor was installed. The Republic Steel Corp. shipped from stock at the Tobin Group and exhausted the stockpile. The Book mine of the North Range Mining

Co. remained idle. Road gravel and sandfill were produced at several pits in the county.

Isabella.—Petroleum and natural gas output continued to decline. Petroleum production totaled 402,000, compared with 487,000 in 1962. Natural gas production dropped from 107 million cubic feet to 6 million. Crude oil was refined at Mount Pleasant by Leonard Refineries, Inc. Marl for agricultural use was dug from a pit near Weidman. Sand and gravel for building and road use was produced.

Jackson.—Petroleum output continued to decline to about 2.3 million barrels from 2.6 million in 1962. Natural gas production was virtually unchanged at 2.2 billion cubic feet. More than 500,000 tons of sand and gravel for fill, building, and paving use was produced. Roadstone and agricultural limestone was quarried and crushed near Parma. Three quarries near Napoleon yielded sandstone which was milled for building use and crushed for foundry use. Broken stone was used for riprap. Marl was dug from a pit near Horton.

Kalamazoo.—Peat was dug from bogs near Kalamazoo and Scotts. Pits near Climax and Vicksburg yielded marl which was dried and sold for soil enrichment. Over 1.2 million tons of sand and gravel was produced at three fixed and several portable plants. Much of the material was used for road construction and maintenance. The last oil-producing field in the county, the Alamo, was abandoned in 1962.

Kalkaska.—Natural gas and petroleum were produced from the Beaver Creek field. The yield was smaller than in 1962 and totaled 19,000 barrels of oil and 47 million cubic feet of gas. The county road commission produced sand and gravel for its own use.

Kent.—Two underground mines operated by Bestwall Gypsum Co. and Grand Rapids Plaster Co. yielded gypsum. The crude material was processed at company-owned plants where wallboard, lath, sheathing, and plaster were produced. Bestwall Gypsum Co. also expanded perlite mined in Nevada. The material was used in building plaster. Peat was dug from bogs near Grand Rapids and Wyoming. Over 2.7 million tons of sand and gravel was produced from large fixed plants in the Grand Rapids area and from portable plants throughout the country. Natural gas and petroleum were produced from the Walker field.

Lapeer.—Wilkinson Chemical Corp. extracted calcium-magnesium chloride from natural well brines at Mayville. Reed-sedge peat production was reported from three operations near Imlay City. About 400,000 tons of sand and gravel was produced with portable plants throughout the county. Oil production totaled 23,357 barrels, up from 1,528 barrels in 1962. All production was from the Rich field which was opened in 1962. During the year six wells were drilled, resulting in five oil wells and one dry hole.

Lenawee.—Masonry and portland cements were manufactured at Cement City by Peninsular Portland Cement Division, General Portland Cement Co. Drain tile was manufactured from miscellaneous clay by Comfort Brick & Title Co., Tecumseh. About 700,000 tons of sand and gravel was produced in the county, mostly for road construction and maintenance. Peat production was reported at two sites. The Medina field yielded a small quantity of petroleum.

Mackinac.—Inland Lime & Stone Co., Division of Inland Steel Co., operated the Port Inland quarry. United States Steel Corp. operated the Cedarville quarry. Both companies have developed extensive processing plants and port facilities nearby on the north shore of Lake Michigan to handle the output of the very large quarry operations. Nearly all of the material was shipped by boat to industrial consumers. Much of the output was used as blast furnace flux. Large quantities also were shipped to chemical plants, cement mills, lime plants, and other industrial consumers. More than 300,000 tons of sand and gravel was produced, mostly for road use. Output was less than half that of 1962 because of completion of highway contracts.

Macomb.—Because of increased building and road construction activity in the northern Detroit metropolitan area, sand and gravel production increased to 3.5 million tons from 1.1 million in 1962. About 2 million tons came from fixed plants and the remainder from portable plants. About three-fifths of the material was used in road construction while the balance was used for building and fill. Natural gas production increased to 1.7 billion cubic feet from 500 million in 1962. Nearly half of the output came from the Ray gas reef which is being steadily developed into a much larger productive area than expected earlier. The remainder of the gas came from the Lenox field. In 1963, 9 gas wells and 21 dry holes were drilled.

Manistee.—Natural well brines of the Filer formation were processed and yielded bromine, calcium-magnesium chloride, and magnesium compounds. In the Manistee area chemical plants were operated by Great Lakes Chemical Corp., Michigan Chemical Corp., Morton Chemical Co., and Standard Lime & Cement Co. Division, Martin Marietta Corp. Value of output was 14 percent larger than in 1962. Salt was recovered from artificial brines by Manistee Salt Works and Morton Salt Co. The Packaging Corp. of America produced regenerated lime for its use by calcining calcium carbonate sludge in a rotary kiln. Industrial sand, as well as building and paving sand and gravel, was produced in the county.

Marquette.—The county maintained its position as the leading mineral producer in the State. Iron ore mines were operated by Cleveland-Cliffs Iron Co., Inland Steel Co., Jones & Laughlin Steel Corp., and North Range Mining Co. Cleveland-Cliffs Iron Co. began producing pellets at its new Empire project, 4 miles south of Negaunee. Initial annual capacity of the Empire plant is 1.2 million tons of pellets, having an expected ultimate capacity of 3 million tons. Cleveland-Cliffs also began construction of an addition to the Republic concentrator that will expand annual capacity of the plant by 400,000 tons. Upon completion, in 1964, total annual capacity of the Republic concentrator will be 2.8 million tons of concentrate. Of this amount, 2 million tons will be agglomerated at the Republic mine site and the remainder at the Eagle Mills pelletizing plant. In December, plans were announced for a $15 million pelletizing plant at the Cleveland-Cliffs Mather underground mine. The project was expected to increase annual production of the mine from 700,000 tons to 2.4 million tons by 1966. The plant will be the first in the Lake Superior District to pelletize high-grade underground ores. Inland Steel Co. ceased mining operations at the Greenwood underground mine at Ishpeming

on April 30. Overall shipments of iron ore from the county increased 30 percent. Output of underground mines was only 4 percent larger than in 1962, while production from open pits increased more than 50 percent. Sand and gravel production totaled 745,000 tons and was used principally for road maintenance and construction.

Mason.—Bromine, calcium chloride, calcium-magnesium chloride, magnesium compounds, and lime were produced by Dow Chemical Co. at plants in the Ludington area. Harbison-Walker Refractories Co. produced refractory magnesia from purchased magnesium hydroxide. Industrial sand (molding, grinding, and polishing), as well as paving sand, was produced. Petroleum output continued to increase—264,000 barrels, compared with 168,000 in 1962. During the year 39 wells were drilled, resulting in 12 oil producers and 27 dry holes. The largest oil production came from the Eden, Scottville, and Wiley fields. Natural gas was recovered from the Eden field; production dropped to one-third of the 1962 output.

Mecosta.—Marl was recovered from deposits in Brockway Lake and Burden Lake. Sand and gravel was produced at fixed plants near Big Rapids and at portable plants throughout the county. Nearly 30,000 barrels of petroleum and 152,000 million cubic feet of natural gas, about the same quantity as in 1962, was produced.

Menominee.—Quicklime and hydrated lime for chemical and industrial use was produced by Limestone Products Division of North Western-Hanna Fuel Co. at Menominee. About 472,000 tons of sand and gravel was produced, mostly for building and paving use.

Midland.—Dow Chemical Co. produced bromine, calcium chloride, calcium-magnesium chloride, iodine, magnesium compounds, and potash from natural brines; salt was produced from artificial brines. Kaiser Aluminum & Chemical Corp. produced refractory magnesia from purchased magnesium hydroxide. Molding sand and sand and gravel for fill, paving, and building was produced near Midland. About 268,000 barrels of petroleum and 15 million cubic feet of natural gas was produced.

Missaukee.—About 500,000 barrels of petroleum was recovered, principally from the McBain and East Norwich fields. About 1 billion cubic feet of natural gas was produced, mostly from the Enterprize and East Norwich fields. Gravel was produced for road construction and maintenance.

Monroe.—Portland and masonry cements were produced at Dundee by the Dundee Cement Co. Clay and limestone deposits near the mill were used for raw material. Clay mined near South Rockwood was used for manufacturing art pottery by F. W. Ritter Sons Co. Limestone quarried at Maybee, Monroe, and Ottawa Lake was crushed and sold for flux, ballast, roadstone, and agricultural limestone. Broken stone was used for riprap. Peat was obtained from bogs near Ida and sold for soil conditioning. About 11,000 barrels of petroleum was recovered from the Deerfield field.

Montcalm.—Petroleum (343,000 barrels) and natural gas output (137 million cubic feet) continued to decline. Most of the petroleum production, as in 1962, came from the Elmore and Reynolds fields. During the year the Day and Pine fields were abandoned. A bog near Lakeview yielded peat (reed-sedge and moss). About 265,000 tons

747-416—64——37

of sand and gravel was produced for building and road use. Crude oil was refined by Crystal Refining Co. of Carson City, Inc.

Muskegon.—Salt was produced from artificial brines at Montague by Hooker Chemical Co. In the Muskegon area industrial sand production was reported by The Nugent Sand Co., Inc. Building and paving sand also was produced in the county. About 13,000 barrels of petroleum and 11 million cubic feet of natural gas were produced. Crude oil was refined at Muskegon by Marathon Oil Co. and by Naph-Sol Refining Co.

Newaygo.—About 119 million cubic feet of gas was recovered from the Ensley gasfield. Nearly 30,000 barrels of petroleum was produced. About 150,000 tons of sand and gravel, mostly used for road construction and maintenance, was recovered from pits throughout the county. A pit near Grant yielded marl for agricultural use.

Oakland.—Nearly 7.9 million tons of sand and gravel was produced at fixed and portable plants throughout the county, more than 23 percent higher than in 1962. The increase was due to greater demand for building and road materials in the Detroit metropolitan area. About 445 million cubic feet of natural gas and a small quantity of petroleum was recovered from the Oakland County portion of the Northville field. Bogs near Clarkston, Farmington, New Hudson, and Novi yielded humus peat, which was processed for horticultural use and soil conditioning.

Oceana.—About 274,000 barrels of petroleum was produced. Elbridge, Pentwater, and Stony Lake fields were the principal producers. A small quantity of natural gas was recovered from the Crystal Valley field. More than 640,000 tons of sand and gravel was produced at fixed and portable plants in the county. Most of the output was used for road construction and maintenance.

Ogemaw.—More than 364,000 barrels of petroleum and 673 million cubic feet of natural gas were produced. Nearly all of the output came from the Rose City and West Branch fields. Osceola Refinery at West Branch refined crude oil. Sand and gravel for building and road use was produced.

Ontonagon.—White Pine Copper Co. (a wholly owned subsidiary of Copper Range Co.) operated a mine, mill, and smelter at White Pine. The company has selected the longwall mining method to gradually supersede the room-and-pillar method now in use. The longwall method will permit maximum extraction from the ore body by permitting controlled caving of the ground after the ore is mined out. Ore will not be left in pillars for roof support. It will take several years to convert the entire operation to this method. In the meantime, the room-and-pillar method will provide ore for the mill while engineering and equipment design will continue to develop ways of improving the costs of longwall mining. Mill capacity was increased 10 percent by the addition of two new rodmills. Concentrate drying equipment was installed which permitted the smelter to achieve the highest level of production in its history. To maintain a balance between mine output and mill and smelter, a computerized study was initiated in 1963. The initial study indicated moves that should help materially to achieve maximum efficiency of operations. In 1962, a semicontinuous casting machine was installed in the smelter for experimental pur-

poses. This unit is now producing and an additional unit is planned to augment production in 1964. Development of the Southwest ore body was suspended; machinery was removed; and the level was allowed to flood. Subsequent discovery of additional ore along the periphery of the main ore body, as well as better grade control and lower mining costs, made it unnecessary to incur the heavy capital costs of putting the new ore body into production. This ore body will be considered part of the future reserve. The silver recovery circuit was operated and the high-silver-bearing concentrates from the circuit were smelted separately for delivery to electrolytic refineries where the silver could be recovered.

More than 500,000 tons of sand and gravel was produced—all of it for fill and road use.

Osceola.—Sand and gravel was produced from pits at Hersey and Reed City. The material was used chiefly for building, paving, and fill. A pit near Tustin yielded marl for soil enrichment. Petroleum output totaled 302,000 barrels, and 235 million cubic feet of natural gas was produced. A major portion came from the Reed City field. Osceola Refining Co. at Reed City refined crude oil.

Ottawa.—Nearly 2.5 million tons of sand and gravel was produced, up from 1.8 million in 1962. Industrial sand as well as sand and gravel for building, paving, and fill was reported. Marl was dug near Hudsonville and Jenison. More than 192,000 barrels of petroleum and 138 million cubic feet of natural gas was recovered. The largest production was reported from the Walker field.

Presque Isle.—Large limestone quarries and processing and port facilities were operated at Rogers City by United States Steel Corp. and at Alpena by Chemstone Corp., agents for Presque Isle Corp. Most of the shipments were by water to steelmills, cement plants, chemical and lime plants, and sugar and paper mills. Substantial quantities also were shipped for concrete aggregate, roadstone, and agricultural limestone. Rough construction stone was quarried at Onaway by Onaway Stone Co. Straits Aggregate & Equipment Corp., Oscoda, operated sand and gravel pits in the Millersburg area and at Rogers City. Road materials were produced. The county and State highway departments also obtained sand and gravel for road maintenance and construction.

Roscommon.—More than 1.2 billion cubic feet of natural gas and 190,000 barrels of petroleum were recovered, much of it from the St. Helens and Headquarters fields. Sand and gravel, totaling 274,000 tons, for fill, building, and paving was obtained from pits in the county.

Saginaw.—Clay for use in manufacturing cement was mined by Aetna Portland Cement Co. Division, Martin Marietta Corp. Michigan Sugar Co. produced hydrated lime for its own use in sugar refining at Saginaw. The county and State highway departments obtained sand and gravel for road construction and maintenance. About 38,000 barrels of petroleum were recovered from Birch Run, Birch-Bela, and Saginaw fields.

St. Clair.—Peerless Cement Co. Division, American Cement Corp., produced portland cement at Port Huron. The company mined clay at Smith Creek for use at the plant. Salt was recovered from arti-

ficial brines at St. Clair by Diamond Crystal Salt Co., and at Marysville by Morton Salt Co. Reed-sedge peat was dug from a bog near Capac. Nearly 470,000 tons of sand and gravel was produced at sites throughout the county. It was used chiefly for building and road construction. More than 900,000 barrels of petroleum and nearly 14.3 billion cubic feet of natural gas was produced. The gas output was the largest in the State.

St. Joseph.—Marl was produced from pits near Colon, Nottawa, and Three Rivers. Moss peat was dug from a bog in the Three Rivers area. Sand and gravel was produced from fixed plants at White Pigeon and Three Rivers. The county and State highway departments contracted for sand and gravel for road construction.

Sanilac.—Hydrated lime was produced at the Croswell plant of Michigan Sugar Co. for use in sugar refining. Bogs near Minden City and Sandusky yielded moss and reed-sedge peat for horticultural use. More than 500,000 tons of sand and gravel were produced, most of it for road construction and maintenance.

Shiawassee.—Michigan Vitrified Tile Co. mined clay near Corunna for use in manufacturing vitrified sewer pipe. About 345,000 tons of sand and gravel was produced at both fixed and portable plants throughout the county.

Tuscola.—Hydrated lime was produced at Caro by Michigan Sugar Co. for use in refining sugar. Nearly 1.5 million tons of sand and gravel was produced. Although much of the material was used in building and road construction, a large amount of molding sand was produced. About 85,000 barrels of petroleum output was reported from four fields, with the major portion coming from the Akron field.

Van Buren.—Industrial sand (molding and engine) was produced at two fixed plants near Covert and South Haven. Road gravel was produced with portable plants at a number of sites throughout the county. About 28,000 barrels of petroleum was recovered. The Paw Paw and Bloomingdale fields yielded the major portion of the output.

Washtenaw.—Nearly 1.5 million tons of sand and gravel was produced from deposits, largely in the Ann Arbor and Ypsilanti area. The material was used primarily for building and road construction. About 24,000 barrels of petroleum was produced from the Northville field. Natural gas production of 345 million cubic feet was less than half of the 1962 output.

Wayne.—The county ranked second in value of mineral production, after Marquette and Houghton Counties. The total was about $2 million more than in 1962. Peerless Cement Co. Division, American Cement Corp., manufactured portland and masonry cement at two plants in Detroit. The company mined clay for its own use from a pit near Allen Park. Wyandotte Chemicals Corp. produced portland cement at Wyandotte. Flat Rock Clay Products Co. mined clay for use in manufacturing drain tile. At Livonia, Light Weight Aggregates Corp. mined clay for its own use. Quicklime was produced at Wyandotte by Wyandotte Chemicals Corp. and at Detroit by Solvay Process Division of Allied Chemical Corp. Most of the output was used in chemicals manufacture. Salt was recovered from

artificial brines, formed by dissolving salt from the Salina formation, at plants in Wyandotte by Pennsalt Chemicals Corp. and Wyandotte Chemicals Corp. International Salt Co. operated an underground mine in Detroit and produced rock salt. Limestone for concrete and roadstone was quarried at the Sibley quarry at Trenton by the Michigan Foundation Quarry Co., Inc. More than 2.2 million tons of sand and gravel was produced from both fixed and portable plants at sites throughout the county. Industrial sand (glass, molding, and blast), as well as building and paving material and fill, was produced in large quantities.

About 13,000 barrels of petroleum and 644 million cubic feet of natural gas were recovered from the Northville field. Crude oil refineries were operated at Detroit by Marathon Oil Co.; at Flat Rock by Petroleum Specialties, Inc.; at Trenton by Socony-Mobile Oil Co., Inc.; and at Wyandotte by Wyandotte Chemicals Corp. Byproduct sulfur was recovered from petroleum by the Parsons process at the Marathon refinery in Detroit. Zonolite Division, W. R. Grace & Co., exfoliated vermiculite at a plant in Dearborn. The crude vermiculite was shipped in from Montana and South Carolina. United States Gypsum Co. operated a calcining and board plant in Detroit.

The Mineral Industry of Minnesota

By L. F. Heising [1] and R. C. Briggs [2]

MINERAL production in Minnesota was valued at $453.5 million, 6 percent larger than in 1962. Minnesota continued as the leading iron-ore-producing State, supplying 60 percent of the total usable ore shipped from mines in the United States. Shipments of iron-bearing ores (including manganiferous ore) increased 3 percent in quantity and accounted for 91 percent of the State total mineral value. Shipments of taconite concentrate reached a record high (16.7 million tons). About 37 percent of the State total iron-ore output was taconite concentrate.

Production of other mineral commodities remained rather stable. Value and quantity increases were recorded for clays, masonry cement, lime, sand and gravel, and stone. Portland cement production increased in quantity, but the value decreased slightly. Production of abrasive stones declined in both quantity and value. Totals for peat show a large quantity decrease but only a small decrease in value because of higher unit prices.

TABLE 1.—Mineral production in Minnesota [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	203	$291	[2] 199	[2] $298
Iron ore (usable)—thousand long tons, gross weight	44,295	385,997	45,435	408,486
Manganiferous ore (5 to 35 percent Mn) short tons, gross weight	292,779	(3)	347,336	(3)
Peat—short tons	[4] 14,386	307	8,110	294
Sand and gravel—thousand short tons	29,399	22,656	30,462	23,318
Stone—do	3,803	10,360	3,898	11,027
Value of items that cannot be disclosed: Abrasive stones, cement, fire clay (1963), gem stones, lime, and values indicated by footnote 3		9,325		10,120
Total		428,936		453,543

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Incomplete figure—fire clay included with "Value of items that cannot be disclosed."
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Revised figure.

[1] Supervising mining engineer, Bureau of Mines, Minneapolis, Minn.
[2] Mining engineer, Bureau of Mines, Minneapolis, Minn.

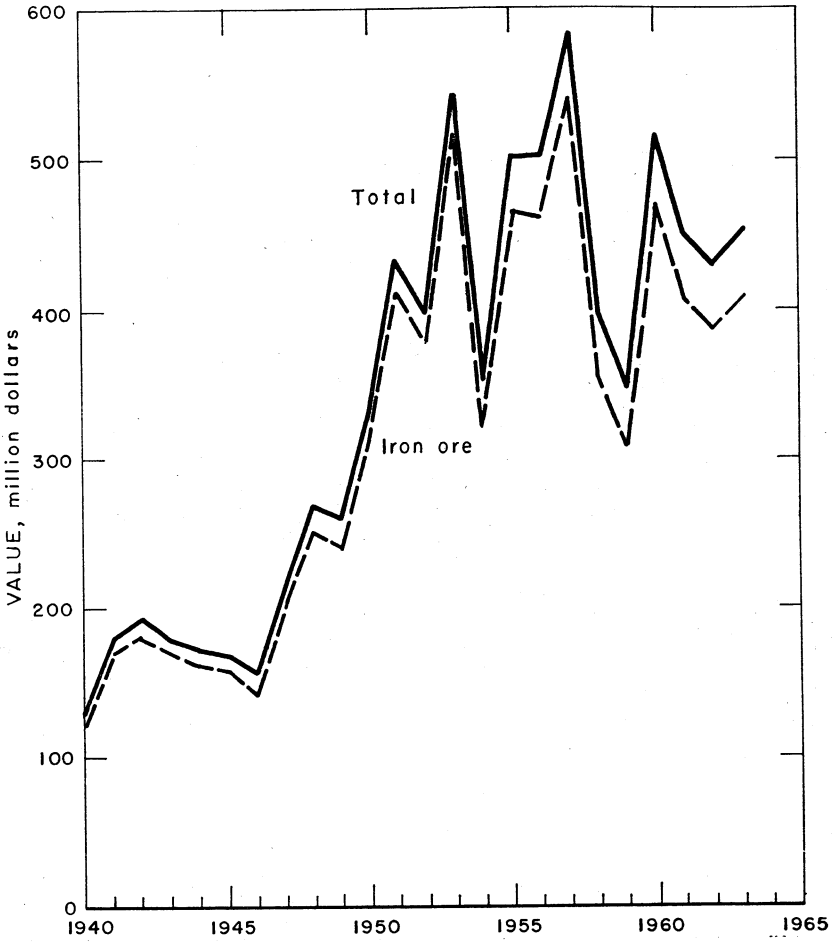


FIGURE 1.—Value of iron-ore shipments and total value of mineral production in Minnesota, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Employment and Injuries.—Over 26.4 million man-hours were worked in Minnesota mineral industries in 1963, excluding officeworkers, compared with 26.9 million man-hours in 1962. The 2-percent drop was attributed to a 900,000 man-hour decline in the iron ore industry which was partially offset by a substantial gain in the granite industry.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$526,004	1958	$393,942
1953	655,959	1959	341,046
1954	408,337	1960	506,850
1955	572,478	1961	435,655
1956	547,924	1962	416,066
1957	593,188	1963	424,358

Six fatalities, three at iron ore mines, two at sand and gravel operations, and one at a granite finishing plant occurred in 1963, compared with three the previous year. The total number of nonfatal disabling injuries decreased to 206 (preliminary figure), compared with the final figure of 264 for 1962.

The Peter Mitchell mine of Reserve Mining Co. won the Sentinels of Safety Trophy, the top award in the open-pit group of the 1963 National Safety Competition. The mine, located near Babbitt, worked 2,379,625 man-hours in 1963 without a disabling work injury. Other Minnesota mines and plants experienced injury-free records in 1963 and received Certificates of Achievement in Safety from the Federal Bureau of Mines.

Water.—To obtain valid data concerning water use by the mineral industries for 1962, the Bureau of Mines conducted a nationwide canvass of virtually all mineral extractive and certain mineral processing industries. Cement plants, lime plants, and other manufacturing operations were excluded. Table 3 summarizes some of the data collected for the State. As used in the table, "new water" is that entering the plant as makeup water and when added to the "water recirculated" gives the total used or required for processing. "Water discharged" is used water leaving the plant. "Water consumed" is that which leaves the plant as moisture combined or entrained in the product or is lost by evaporation and no longer available for reuse in the vicinity of the plant.

TABLE 3.—Water statistics for selected mineral industries in 1962

(Million gallons)

Industry	New water	Water recirculated	Total water used	Water discharged	Water consumed
Iron and manganiferous ores	98,218	97,689	195,907	93,958	4,260
Stone	1,391	66	1,456	1,379	12
Sand and gravel	2,705	1,470	4,175	2,600	105
Total	102,314	[1] 99,224	201,538	[1] 97,938	[1] 4,376

[1] Data do not add to total shown because of rounding.

REVIEW BY MINERAL COMMODITIES

METALS

Iron Ore.—Minnesota mines shipped 45.4 million long tons of usable iron ore (excluding ore containing 5 percent or more manganese), 3 percent more than in 1962. Total mine value of usable ore increased

to $408.5 million. Average weighted mine value for Minnesota usable ore was $8.99 per ton. The small increase over the 1962 value was due to the higher proportion of taconite concentrate shipped. Average natural iron content of usable ore produced was 56.4 percent, compared with 55.8 percent in 1962.

Nineteen mining companies produced iron ore from five counties. Mesabi Range mines in St. Louis and Itasca Counties produced 96 percent of the total. The Vermilion Range in St. Louis County contributed 2 percent; the Cuyuna Range in Crow Wing County and the Spring Valley District in Fillmore and Olmsted Counties each furnished 1 percent.

The United States Steel Corp., Minnesota Ore Operations (formerly Oliver Iron Mining Division, United States Steel Corp.), terminated its leases on the Fayal and Spruce mines near Eveleth. Mesabi Range mines closed during the year included the St. James mine operated by Oglebay Norton Co. near Aurora and the Bennett mine operated by Pickands Mather & Co. near Keewatin. Snyder Mining Co. closed the exhausted Webb mine near Hibbing. The Hanna Mining Co., Agents, closed its Robert mine near Crosby on the Cuyuna Range. Rhude & Fryberger reopened the Wade mine, and Pickands Mather & Co. reopened the Rabbit Lake mine.

TABLE 4.—Dates of first and final cargoes of iron ore at U.S. upper Great Lakes ports

Port and dock	1962		1963	
	First	Final	First	Final
Ashland, Wis.:				
C&NW	May 9	Nov. 9	May 19	Nov. 14
Soo Line	May 9	Nov. 9	May 19	Nov. 14
Duluth, Minn.: DM&IR	May 12	Oct. 23	Apr. 29	Nov. 11
Escanaba, Mich.: C&NW	Apr. 17	Nov. 25	Apr. 19	Dec. 16
Marquette, Mich.:				
Soo Line	May 2	Nov. 8	May 21	Nov. 21
LS&I	Apr. 21	Dec. 4	Apr. 25	Dec. 5
Silver Bay, Minn.: Reserve	Apr. 18	Nov. 24	Apr. 23	Dec. 5
Superior, Wis.:				
GN	Apr. 21	Nov. 27	Apr. 25	Dec. 11
NP-Soo Line	Apr. 24	Nov. 16	Apr. 29	Oct. 24
Taconite Harbor, Minn.: Erie	Apr. 17	Dec. 13	Apr. 29	Dec. 7
Two Harbors, Minn.: DM&IR [1]	Apr. 20	Nov. 7	----------	----------

[1] Docks not utilized in 1963.

Source: Skillings' Mining Review.

TABLE 5.—Usable iron ore [1] produced (direct-shipping and all forms of concentrate), by ranges

(Thousand long tons)

Year	Cuyuna	Mesabi	Vermilion	Spring Valley district	Total
1954–58 (average)	1,930	54,860	1,297	280	58,367
1959	745	33,747	809	576	35,877
1960	1,166	54,442	1,361	473	57,442
1961	1,095	41,199	930	491	43,714
1962	655	43,041	1,158	362	45,216
1963	515	43,570	774	524	45,383

[1] Exclusive of iron ore containing 5 percent or more manganese.

TABLE 6.—Crude iron ore [1] data, in 1963, by counties and ranges

(Thousand long tons)

County and range	Stocks Jan. 1	Production		Shipments		Stocks Dec. 31
		Underground	Open pit	Direct to consumers	To beneficiation plants	
County:						
Crow Wing	27	278	245	366	143	41
Fillmore [2]			970		970	
Itasca			24,076	194	23,882	
St. Louis	863	1,011	73,804	6,908	68,087	683
Total	890	1,289	[3] 99,094	7,468	93,082	724
Range:						
Cuyuna	27	278	245	366	143	41
Mesabi	824	129	97,879	7,052	91,097	683
Vermilion	39	882		49	872	
Spring Valley district			970		970	
Total	890	1,289	99,094	[3] 7,468	93,082	724

[1] Exclusive of ore containing 5 percent or more manganese.
[2] Includes ore from three properties in Olmsted County.
[3] Data do not add to total shown because of rounding.

TABLE 7.—Usable iron ore [1] data, in 1963, by counties and ranges

(Thousand long tons)

County and range	Stocks Jan. 1	Production	Iron content of production	Shipments	Stocks Dec. 31
County:					
Crow Wing	[2] 96	515	254	529	81
Fillmore [3]	7	524	246	502	28
Itasca	1,134	9,523	5,262	9,374	1,283
St. Louis	3,756	34,822	19,814	35,029	3,549
Total	[2] 4,993	[4] 45,383	25,576	[4] 45,435	4,941
Range:					
Cuyuna	[2] 96	515	254	529	81
Mesabi	4,622	43,570	24,611	43,637	4,555
Vermilion	268	774	466	766	277
Spring Valley district	7	524	246	502	28
Total	[2] 4,993	45,383	[4] 25,576	[4] 45,435	4,941

[1] Exclusive of ore containing 5 percent or more manganese.
[2] Revised figure.
[3] Includes ore from three properties in Olmsted County.
[4] Data do not add to total shown because of rounding.

The trend toward beneficiation of crude ore and agglomeration of concentrates continued, reflecting the technological advance of the steel industry. A uniform sized iron-ore concentrate, such as taconite pellets, increases the efficiency and capacity of a blast furnace. In 1963, nearly 84 percent of the total usable ore shipped was beneficiated. Shipments of taconite pellets increased 20 percent and reached a record high. Reserve Mining Co. and Erie Mining Co. (Pickands Mather & Co., operating agents) operated large-scale taconite-processing plants at Silver Bay and Hoyt Lakes, respectively. Each company set new production records. Reserve completed a $120 million

expansion program in February, increasing its annual production capacity to 9 million tons of pellets. Erie Mining Co. began development work on a new mine, expected to open by 1965, near Dunka River to supplement the crude ore supply for its Hoyt Lakes plant. Erie planned a 12-mile railroad to the new operation.

TABLE 8.—Iron ore [1] shipped from Minnesota mines

(Thousand long tons)

Year	Crude ore to concentrators	Beneficiated			Total usable ore [2]	Proportion of beneficiated to total usable ore (percent)
		Agglomerates	Other	Total		
1954-58 (average)	54,458	4,820	20,359	25,179	58,166	43.29
1959	48,024	8,401	11,513	19,914	36,109	55.15
1960	88,060	11,489	21,693	33,181	54,723	60.63
1961	79,825	14,366	17,698	32,064	44,699	71.73
1962	85,729	14,085	18,744	32,829	44,295	74.11
1963	93,082	16,857	21,110	37,967	45,435	83.56

[1] Exclusive of ore containing 5 percent or more manganese.
[2] Direct-shipping and beneficiated ore.

A number of companies directed their attention and research toward exploiting deposits of taconite and other low-grade material. The adoption of a State constitutional amendment by the State legislature in March contributed to the increased activity. This amendment, if approved by the voters of Minnesota in November 1964, would assure the taconite industry of certain taxation limitations at the State level for 25 years.

The United States Steel Corp. continued operating its pilot taconite plant near Mountain Iron. They awarded contracts covering the engineering design of a proposed taconite-concentrating plant with a capacity of 4 million tons of pellets per year, to be built at the same site.

The Eveleth Taconite Co., jointly owned by Oglebay Norton Co. and the Ford Motor Co., announced plans to start construction on a taconite-concentrating plant near Forbes in the spring of 1964. The plant will have a designed capacity of 1.5 to 2 million tons of pellets per year. The Minnesota Department of Conservation approved the construction of a dam on the nearby St. Louis River. Congressional action on a bill to permit this dam is pending. Federal approval is required because the St. Louis River is classed as navigable water. A reservoir formed by this dam will provide the 9,000 gallons per minute necessary for operating the plant.

The Hanna Mining Co., Agents, and the United States Steel Corp. conducted research on nonmagnetic taconite at pilot plants near Cooley and Coleraine, respectively. W. S. Moore Co. and Northern Natural Gas Co. initiated a research program directed toward developing a new roasting method to process low-grade nonmagnetic ores. W. S. Moore also began construction on a pilot plant to study the agglomeration of iron-ore concentrates by hot briquetting. The Jessie H. Mining Co. erected a fines-treating plant in conjunction with its washing plant near Coleraine.

The 1963 navigation season for ports shipping Minnesota iron ores opened April 23 at Silver Bay and closed December 11 at Superior. Vessel freight rates to lower Lake ports were reduced 10 cents per ton in August. This reduction did not affect the mine value because the freight rate saving was passed on to the buyer. Lake Erie base prices for iron ore quoted at the end of 1963 were 10 cents per ton lower than those of 1962, due to the lower freight rate.

The Federal Area Redevelopment Administration sponsored R–N direct reduction tests and a Krupp-Renn feasibility study.[3] The Iron Range Resources and Rehabilitation Commission and ARA granted funds to Cuyuna Minerals Research, Inc., to begin a study of beneficiating techniques applied to Cuyuna low-grade ores. The Federal Bureau of Mines continued research on beneficiation of nonmagnetic and semitaconites at its Minneapolis Research Center. Several reports and articles were published describing the Bureau's activities and results.[4]

Manganiferous Ore.—Manganiferous ore (containing 5 to 35 percent manganese, natural) shipments, all from the Cuyuna Range, increased 19 percent over those of 1962. Total shipments were 347,336 short tons. All shipments were ferruginous manganese ore or concentrates (containing 10 to 35 percent manganese, natural). Cuyuna Range mines did not produce or ship any manganiferous iron ore (containing 5 to 10 percent manganese, natural), although ore was blended at the upper Lake ports to produce this grade. Newly mined ore accounted for 88 percent of the total shipments. The remainder was shipped from stockpiles. Average natural iron and manganese contents of the ores shipped were 33.39 and 12.18 percent, respectively.

Five Cuyuna Range mines, all in Crow Wing County, shipped manganiferous ore. Producing companies were The Hanna Mining Co., Agents, Pickands Mather & Co., and Pittsburgh Pacific Co. The Pittsburgh Pacific Co. mined ore from the Sultana-Hopkins mine under contract from Pickands Mather & Co.

Total value of manganiferous ores shipped increased 19 percent. The price of manganiferous ores (containing more than 5 percent manganese, natural) was generally that of Old Range non-Bessemer iron ore. This price was based on the combined natural iron and manganese content, plus a premium for the natural manganese in excess of 5 percent.

The Federal Bureau of Mines continued research at its Minneapolis Research Center on developing methods of utilizing the potential manganese resources of the Cuyuna Range. Two reports describing techniques and test results of the sulfatization process for recovery of manganese were published.[5]

---

[3] U.S. Department of Commerce. Preliminary Engineering Studies for Application of the R–N Process to Lake Superior Region Iron Ores. 1963, 102 pp.

[4] Fine, M. M. A Process of Simultaneous Agglomeration and Reduction of Iron Ores. Proc. 8th Biennial Briquetting Conf., 1963, pp. 49–60.

Melcher, N. B. Smelting Prereduced Pellets in an Experimental Blast Furnace. Minnesota Univ., Proc. 24th Ann. Min. Symp., 1963, pp. 47–53.

Melcher, N. B., and D. W. Frommer. Flotation of Iron Ores. Min. Cong. J., v. 49, No. 12, 1963, pp. 29–33.

Wasson, P. A., R. T. Sorensen, and D. W. Frommer. Anionic Flotation of Silica From Goethitic Iron-Bearing Materials, Cuyuna Range, Minn. BuMines Rept. of Inv. 6199, 1963, 11 pp.

[5] Prasky, Charles, and G. P. Howard. Sulfatization of Manganiferous Carbonate Slates in a Fluidized Bed Reactor. BuMines Rept. of Inv. 6258, 1963, 16 pp.

Prasky, Charles, F. E. Joyce, Jr., and W. S. Swanson. Differential Sulfatizing Process for the Recovery of Ferrograde Manganese. BuMines Rept. of Inv. 6160, 1963, 30 pp.

TABLE 9.—Shipments of usable[1] manganiferous iron ore and ferruginous manganese ore from mines in the Cuyuna Range

Year	Manganiferous iron ore (5 to 10 percent Mn, natural)			Ferruginous manganese ore (10 to 35 percent Mn, natural)			Total shipments (long tons)
	Shipments (long tons)	Contents (natural)		Shipments (long tons)	Contents (natural)		
		Fe (percent)	Mn (percent)		Fe (percent)	Mn (percent)	
1954–58 (average)	463,825	39.71	6.10	83,586	33.51	12.38	547,411
1959	273,541	39.35	6.42	109,586	34.34	11.76	383,127
1960	345,426	38.97	7.15	48,349	34.37	12.74	393,775
1961	80,603	32.05	9.01	81,750	35.58	12.29	162,353
1962	129,979	40.40	6.19	131,431	33.28	12.60	261,410
1963				310,121	33.39	12.18	310,121

[1] Direct-shipping and beneficiated ore.

NONMETALS

Abrasive Stones.—The Jasper Stone Co. produced grinding pebbles and tube-mill liners from its quartzite deposit near Jasper in Rock County. Sales of grinding pebbles decreased in both quantity and value, whereas sales of tube-mill liners increased in quantity but recorded a slight value decrease. Total output of abrasive stones decreased in both quantity and value.

Cement.—Shipments of portland and masonry cements showed a quantity gain, but the total value remained nearly the same as that reported for 1962. Universal Atlas Cement Division of United States Steel Corp. operated three kilns, at the only cement plant in the State, at Duluth. In addition to masonry cement, the company produced both types I and II (general-use and moderate-heat) portland cement and portland-slag cement. A small amount of type III (high-early strength) was shipped. Shipments of portland and masonry cement were primarily to consumers in Minnesota, North Dakota, and Wisconsin. Several major producers began construction of distribution facilities in the Minneapolis-St. Paul metropolitan area, stressing that cement distribution centers will play an important part in the future of the industry.

Clays.—Total production of clays increased in both quantity and value. Clay was produced by five companies operating in Brown, Carlton, Goodhue, Hennepin, Ramsey, and Redwood Counties. North Central Lightweight Aggregate Co., Inc., the largest clay producer in the State, used its entire output in manufacturing lightweight aggregate. Other uses for clay included manufacturing building brick, floor and wall tile, vitrified sewer pipe, and other products.

Red Wing Potteries, Inc., produced dinnerware and art pottery at its plant in Red Wing, chiefly from raw materials produced in other States.

Gem Stones.—Amateur gem collectors and hobbyists gathered semiprecious gem stones (principally agate) along the north shore of Lake Superior, along the Mississippi River, and from gravel pits in the southeastern part of the State. The material was used mainly for personal gem collections or in handmade jewelry.

Lime.—Output of quicklime and hydrated lime showed substantial gains in both quantity and value. American Crystal Sugar Co. produced a large share of the total, using all its production in its sugar refineries at Chaska, Crookston, East Grand Forks, and Moorhead.

Cutler-Magner Co., the only commercial lime producer in the State, operated a plant near Duluth. Shipments from this plant were chiefly to consumers in Minnesota and neighboring States. About 89 percent of the company's total output was for chemical and industrial purposes, and the remainder was for construction and agricultural use.

Peat.—Six companies reported peat production from operations in Aitkin, Beltrami, Carlton, Itasca, Pine, and St. Louis Counties. Sales, compared with those of 1962, decreased 44 percent, although the value decrease was only 4 percent. Moss peat was the predominant type of peat produced, but some reed-sedge peat and humus were also produced.

Peat was used for soil improvement and other horticultural purposes. It was sold in bulk and polyethylene bags ranging in size from 1 quart to 6 cubic feet.

Perlite.—Minnesota Perlite Corp. and Western Mineral Products Co. operated perlite-processing plants in Minneapolis, using crude material mined in Nevada and New Mexico. Sales of expanded perlite decreased from those in 1962. The expanded product was used as a lightweight aggregate in plaster and concrete and for soil conditioning.

Sand and Gravel.—Sand and gravel operations in Minnesota produced 30.5 million tons, valued at $23.3 million, increases of 4 and 3 percent, respectively, over 1962. An increase of 1.9 million tons for roadbuilding and paving more than offset decreases recorded for building and railroad ballast. The amount used for fill increased 22 percent, and the production of special sands, such as glass, engine, and oil (hydrafrac), remained quite stable.

About 79 percent of the total production was for paving and fill, 19 percent for building, and the remaining 2 percent for other uses. Sixty-five percent of the total output was supplied by 322 commercial operations, and Government-and-contractor operations supplied the rest. Nearly 91 percent was shipped by truck, 4 percent by rail, and 5 percent by river barge.

Sand and gravel production was reported from all 87 counties in the State. Major producing areas were in Clay, Dakota, Hennepin, Jackson, Mower, Otter Tail, Polk, Ramsey, St. Louis, and Washington Counties, which furnished 42 percent of the total.

Stone.—Combined output of basalt, granite, limestone, marl, and quartzite was 3.9 million tons, an increase of 3 percent in quantity and 6 percent in value, compared with the 1962 figures. The increase was attributed mainly to increased sales of dimension granite for architectural purposes and crushed granite for railroad ballast.

Limestone was produced in 16 counties in the southeastern and south-central parts of the State, with the greatest production coming from Blue Earth, Le Sueur, Olmsted, Scott, Washington, and Winona Counties. Total limestone production decreased but registered a value gain mainly because of higher unit values for crushed material used for concrete aggregate and roadstone. Sales of dimension stone

and agricultural limestone increased. Methods of shipping commercial limestone were truck (92 percent), water (7 percent), and rail (1 percent).

TABLE 10.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	3,800	$2,941	3,282	$2,591
Paving	1,824	1,350	1,568	1,056
Railroad ballast	(1)	(1)	4	2
Fill	408	265	489	215
Molding	60	219	58	238
Undistributed [2]	232	631	218	634
Total	[3] 6,325	[3] 5,407	5,619	4,736
Gravel:				
Building	2,807	4,089	2,414	3,416
Paving	9,062	6,683	10,836	8,258
Railroad ballast	489	297	384	198
Fill	294	151	447	295
Other	113	74	70	50
Total	12,765	11,294	14,151	12,217
Total sand and gravel	19,090	16,701	19,770	16,953
Government-and-contractor operations:				
Sand:				
Paving	2,616	1,407	2,056	1,096
Fill	83	28	49	23
Other	57	21	7	1
Total	2,756	[3] 1,455	2,112	1,120
Gravel:				
Building	3	2	26	14
Paving	7,177	4,364	8,090	5,061
Fill	341	118	393	146
Other	32	16	72	24
Total	7,553	4,500	8,581	5,245
Total sand and gravel	10,309	5,955	[3] 10,692	6,365
All operations:				
Sand	9,081	6,862	[3] 7,730	[3] 5,855
Gravel	20,318	15,794	22,732	17,462
Grand total	29,399	22,656	30,462	[3] 23,318

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes glass, engine, filler, blast, oil (hydrafrac), foundry, and other construction sand (1962-63) pottery and other industrial sands (1963), and items indicated by footnote 1.
[3] Data do not add to total shown because of rounding.

Granite production was reported from Big Stone, Kanabec, Lac qui Parle, Mille Lacs, Redwood, Renville, Stearns, and Yellow Medicine Counties. Output of dimension granite, used chiefly for building and monumental purposes, increased slightly. Finishing plants were operated at St. Cloud, Cold Spring, and Delano. Delano Granite Works, Inc., announced plans to increase shaping and finishing facilities at its plant.

Crushed and broken granite production recorded a 24-percent increase over that of 1962, principally because of an increase in the amount for railroad ballast.

TABLE 11.—Granite sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough monumental—thousand cubic feet	(1)	(1)	17	$54
Dressed monumental—do	105	$1,107	78	808
Undistributed [2]—do	199	2,397	235	2,960
Total—approximate thousand short tons [3]	25	3,504	27	3,822
Crushed and broken:				
Riprap—thousand short tons	2	3	5	9
Concrete aggregate and roadstone—do	96	175	78	149
Railroad ballast [4]—do	354	466	469	554
Stone sand—do	1	1	8	2
Total—do	453	645	[5] 561	[5] 715
Grand total—do	478	4,149	[5] 589	4,537

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes granite for rough monumental (1962) and rough and dressed architectural.
[3] Average weight of 166 pounds per cubic foot used to convert cubic feet to short tons.
[4] Includes poultry grit to avoid disclosing individual company confidential data.
[5] Data do not add to total shown because of rounding.

TABLE 12.—Limestone sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough construction and rubble—thousand short tons	(1)	(1)	5	$42
Rough architectural—thousand cubic feet	11	$40	(1)	(1)
Sawed stone [2]—do	24	118	22	99
House stone veneer—do	132	323	106	290
Cut—do	140	1,518	150	1,538
Flagging—do	(1)	(1)	(1)	(1)
Total—approximate thousand short tons [3]	27	2,023	29	2,020
Crushed and broken:				
Riprap—thousand short tons	70	92	24	27
Concrete aggregate and roadstone—do	2,726	3,064	2,656	3,192
Agriculture—do	367	571	426	665
Asphalt—do	52	289	(1)	(1)
Other [4]—do	11	30	61	356
Total—do	3,226	[5] 4,045	[5] 3,166	[5] 4,241
Grand total—do	[5] 3,254	6,068	3,195	[5] 6,260

[1] Figure withheld to avoid disclosing individual company confidential data; included with total.
[2] Excludes house stone veneer.
[3] Average weight of 160 pounds per cubic foot used to convert cubic feet to short tons.
[4] Includes limestone for flux, mineral food, and asphalt and poultry grit (1963).
[5] Data do not add to total shown because of rounding.

Quartzite production from Nicollet and Rock Counties decreased substantially from the 1962 output. The largest drops recorded were in output for concrete aggregate and roadstone, riprap, and refractories. Sales of material for filters and poultry grit increased.

Zenith Dredge Co. in St. Louis County produced crushed and broken basalt for concrete aggregate, roadstone, and railroad ballast. Output increased markedly over that of 1962.

Calcareous marl for agricultural use recorded an increase of over 29 percent in both quantity and value over 1962 figures. Marl was produced by two companies in Cass and Wadena Counties.

Sulfur.—Elemental sulfur was recovered by the Great Northern Oil Co. as a byproduct at its Pine Bend refinery in Dakota County. Gains in quantity and value over those of 1962 were reported.

Vermiculite.—Crude vermiculite mined in Montana was exfoliated by three companies in Hennepin and Ramsey Counties. Output was nearly the same as reported for 1962. Material was used for plaster and concrete aggregate, insulation, litter, fireproofing, acoustical purposes, and miscellaneous uses.

REVIEW BY COUNTIES

Mineral production was reported from every county in the State. St. Louis County, with its large-scale iron mining industry, furnished 74 percent of the State total value.

Mineral value of 15 counties exceeded $1 million. Decreases in iron-ore values for Itasca and Crow Wing continued, but St. Louis and Fillmore reversed the 1962 trend and registered value increases. Mineral output increased in 49 counties and decreased in 38 counties. Virtually all gains or decreases, except in iron-ore producing counties, were attributed to demand for road construction materials. Sand and gravel was produced in all 87 counties. Stone was produced in 29 counties. Some counties are not reported in the text of the County Review section; however, all counties and the minerals produced are listed in table 13. Value of sand and gravel and stone production which could not be credited to a county source is included under "Undistributed" in table 13.

Aitkin.—Sand and gravel was produced by C. L. Stodolka and Ulland Bros., Inc., in portable plants. The State and county highway departments produced sand and gravel for their own uses. Kimball & Son produced moss peat near Hill City for horticultural use.

TABLE 13.—Value of mineral production in Minnesota, by counties

County	1962	1963	Minerals produced in 1963 in order of value
Aitkin	(1)	$66,852	Sand and gravel, peat.
Anoka	(1)	(1)	Sand and gravel.
Becker	(1)	(1)	Do.
Beltrami	(1)	(1)	Sand and gravel, peat.
Benton	$213,158	151,189	Sand and gravel.
Big Stone	347,153	547,812	Stone, sand and gravel.
Blue Earth	1,394,924	1,331,468	Do.
Brown	241,632	221,371	Sand and gravel, clays.
Carlton	416,358	419,163	Peat, sand and gravel, clays.
Carver	229,193	408,368	Sand and gravel, lime.
Cass	123,039	135,962	Sand and gravel, stone.
Chippewa	199,991	198,060	Sand and gravel.
Chisago	122,349	129,550	Do.
Clay	1,019,576	1,063,095	Sand and gravel, lime.
Clearwater	7,671	7,598	Sand and gravel.
Cook	121,011	17,958	Do.
Cottonwood	257,601	(1)	Do.
Crow Wing	6,396,197	5,670,232	Iron ore, manganiferous ore, sand and gravel.
Dakota	1,623,304	1,273,201	Sand and gravel, stone.
Dodge	(1)	(1)	Stone, sand and gravel.
Douglas	82,378	234,557	Sand and gravel.
Faribault	202,943	335,229	Do.
Fillmore	2,521,795	3,308,806	Iron ore, stone, sand and gravel.

See footnotes at end of table.

TABLE 13.—Value of mineral production in Minnesota, by counties—Continued

County	1962	1963	Minerals produced in 1963 in order of value
Freeborn	$309,934	$282,004	Sand and gravel.
Goodhue	359,943	522,754	Stone, sand and gravel, clays.
Grant	167,849	47,843	Sand and gravel.
Henrepin	3,600,607	3,062,455	Sand and gravel, clays.
Houston	(1)	(1)	Stone, sand and gravel.
Hubbard	87,430	53,083	Sand and gravel.
Isanti	(1)	102,413	Do.
Itasca	76,531,060	72,799,306	Iron ore, sand and gravel, peat.
Jackson	169,313	160,463	Sand and gravel.
Kanabec	(1)	250,320	Sand and gravel, stone.
Kandiyohi	342,498	393,660	Sand and gravel.
Kittson	162,198	35,794	Do.
Koochiching	7,180	156,656	Do.
Lac qui Parle	466,793	587,155	Stone, sand and gravel.
Lake	59,191	231,276	Sand and gravel.
Lake of the Woods	99,585	186,123	Do.
Le Sueur	1,762,495	1,546,887	Sand and gravel, stone.
Lincoln	95,141	51,516	Sand and gravel.
Lyon	144,088	297,818	Do.
McLeod	156,254	236,996	Do.
Mahnomen	(1)	(1)	Do.
Marshall	224,490	71,558	Do.
Martin	249,234	198,794	Do.
Meeker	(1)	(1)	Do.
Mille Lacs	(1)	391,902	Stone, sand and gravel.
Morrison	(1)	75,426	Sand and gravel.
Mower	730,024	680,317	Stone, sand and gravel.
Murray	105,417	37,978	Sand and gravel.
Nicollet	282,376	259,930	Sand and gravel, stone.
Nobles	179,645	127,169	Sand and gravel.
Norman	(1)	(1)	Do.
Olmsted	541,688	1,029,421	Stone, iron ore, sand and gravel.
Otter Tail	272,714	1,094,945	Sand and gravel.
Pennington	71,494	99,531	Do.
Pine	49,224	178,453	Sand and gravel, peat.
Pipestone	239,433	100,377	Sand and gravel.
Polk	927,318	1,202,282	Sand and gravel, lime.
Pope	81,761	187,392	Sand and gravel.
Ramsey	747,594	678,593	Sand and gravel, clays, stone.
Red Lake	(1)	23,789	Sand and gravel.
Redwood	100,974	270,217	Sand and gravel, stone, clays.
Renville	339,393	426,458	Sand and gravel, stone.
Rice	270,562	473,291	Do.
Rock	478,999	388,333	Sand and gravel, abrasives, stone.
Roseau	193,192	142,814	Sand and gravel.
St. Louis	310,465,606	337,242,991	Iron ore, cement, sand and gravel, lime, stone, peat.
Scott	903,003	872,095	Stone, sand and gravel.
Sherburne	(1)	149,526	Sand and gravel.
Sibley	453,483	370,868	Do.
Stearns	2,790,357	3,228,276	Stone, sand and gravel.
Steele	296,606	306,181	Sand and gravel, stone.
Stevens	(1)	108,694	Sand and gravel.
Swift	147,447	224,905	Do.
Todd	114,544	(1)	Do.
Traverse	(1)	39,244	Do.
Wabasha	273,229	306,945	Stone, sand and gravel.
Wadena	25,470	95,435	Sand and gravel, stone.
Waseca	----------	49,440	Sand and gravel.
Washington	1,975,775	2,272,633	Sand and gravel, stone.
Watonwan	53,217	70,798	Sand and gravel.
Wilkin	21,438	60,651	Do.
Winona	854,561	1,220,895	Stone, sand and gravel.
Wright	239,736	(1)	Sand and gravel.
Yellow Medicine	423,927	340,598	Stone, sand and gravel.
Undistributed [2]	3,769,404	1,918,862	
Total	428,936,000	453,543,000	

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes some sand and gravel and stone that cannot be assigned to specific counties and values indicated by footnote 1.

Anoka.—Sand for molding and foundry use was produced by the Minnesota Silica Sand Co. J. W. Craig Co. produced paving gravel at a portable plant near St. Francis. The county highway department produced and contracted for paving gravel and fill for road-building.

Becker.—The Becker County Sand & Gravel Co. produced material for paving, building, engine use, fill, and railroad ballast at a stationary plant near Detroit Lakes. The State and county highway departments produced sand and gravel for highway construction.

Beltrami.—Ulland Bros., Inc., produced paving gravel at a portable plant near Bemidji. The State highway department produced sand and gravel primarily for road construction. Peat was produced and packaged for horticultural use by the Minnesota Peat Co. at a plant near Kelliher.

Benton.—Value of mineral production dropped considerably owing to completion of road projects. Sand and gravel was produced by Henry J. Sakry Co. near Foley. The State and county highway departments produced and/or contracted for material for road construction.

Big Stone.—Delano Granite Works, Inc., and Cold Spring Granite Co. quarried granite near Odessa and Ortonville, respectively. The rough material was finished for architectural and monumental purposes at plants in Delano and Cold Spring. Sand and gravel for road construction and building was produced by Hallett Construction Co., John Dieseth Co., and Duininck Bros. & Gilchrist. State and county highway departments contracted for and produced road material.

Blue Earth.—Vetter Stone Co. and Mankato Stone Co. produced dimension limestone principally for architectural use. Lundin Construction Co. and Mankato Ag Lime & Rock Co. produced crushed and broken limestone near Mankato for agricultural use, road construction, and riprap. Sand and gravel for building and road construction was produced by Guaranteed Gravel & Sand Co., Hallett Construction Co., Hiniker Sand & Gravel Co., and North Star Concrete Co. from pits near Mankato.

Brown.—Shale was produced from a pit near Springfield by Ochs Brick & Tile Co. The output was chiefly used for producing building brick and lightweight aggregate. About 219,000 tons of sand and gravel was produced for road construction, fill, building, and other uses. Portable plants were operated by Roberts Bros. and the State highway department. Stationary plants near Springfield and New Ulm were operated by Math N. Schumacher and Wallner Construction Co., Inc., respectively.

Carlton.—About 279,000 tons of sand and gravel was produced by five companies and three governmental units from pits near Moose Lake, Carlton, and Cloquet. The sand and gravel was used for railroad ballast, fill, building, and road construction.

Red Wing Peat Corp. produced sphagnum peat from a bog near Cromwell. The material was processed and dried in a rotary oil-fired kiln and marketed mostly in 6-cubic-foot polyethylene bags.

Carver.—American Crystal Sugar Co. produced quicklime at Chaska and used the entire output for sugar refining. Sand and gravel was produced by Rosenwinkel Sand & Gravel Co., Inc., and Wm. Mueller & Sons at fixed plants near Chaska and Hamburg, respectively. Jay W. Craig Co. operated a portable plant near Shakopee. Output was chiefly for road construction and building.

Clay.—Quicklime was produced by American Crystal Sugar Co. at Moorhead for use in sugar refining. Sand and gravel (608,000 tons) was produced by five companies and the State highway department from fixed and portable plants near Glyndon, Moorhead, Sabina, and Hawley. Output was used for building, road paving, and fill.

Cook.—Erie Mining Co. shipped 8.2 million tons of taconite concentrate pellets from Taconite Harbor, record shipments since the port opened in 1957. Pellets were produced at Erie's large processing plant at Hoyt Lakes, St. Louis County. First cargo of the 1963 season was loaded April 29 and the final cargo left Taconite Harbor on December 7.

Sand and gravel was produced at a fixed plant at Grand Marais by Edwin E. Thoreson, Inc. The county highway department contracted for paving gravel.

Crow Wing.—Total shipments of manganiferous ore increased 19 percent over those of 1962. Iron-ore shipments decreased about 23 percent. Operating companies and mines from which iron and/or manganiferous ores were shipped were as follows:

Company:	*Mines*
The Hanna Mining Co	Robert, Hillcrest Extension, Mahnomen, and Rabbit Lake Trespass.
Pickands Mather & Co	Rabbit Lake and Sultana-Hopkins.
Pittsburgh Pacific Co	Mangan No. 1 and Mangan-Joan.
Inland Steel Co	Armour No. 2.

These mines were open pits except for the Armour No. 2 underground mine. About 47 percent of the manganiferous ores and 69 percent of the iron ores shipped were classed as direct shipping; the remainder was concentrate. The Mahnomen mine shipments were from concentrate stockpiles; the mine was depleted in 1962. The Hanna Mining Co. exhausted the Hillcrest Extension and Robert mines during the 1963 ore season; stockpiles of concentrate remain at both properties. Ore from these mines was washed and sized at the Portsmouth concentrator prior to shipment. In July, Pickands Mather & Co. reopened the Rabbit Lake mine, idle since 1961. The Sultana-Hopkins mine was operated by Pittsburgh Pacific Co. under contract to Pickands Mather & Co. The Pittsburgh Pacific Co. shipped and depleted the Mangan-Joan concentrate stockpile.

Ripley Sand & Gravel, Inc., and Les Roberts Sand, Gravel & Excavating Co. operated fixed sand and gravel plants near Brainerd and produced material for road construction, building, and other purposes. C. L. Stodolka Co., Inc., operated a portable plant near Brainerd and produced material for road construction. The county highway department produced and contracted for paving gravel for road construction.

Dakota.—Sand and gravel was produced by eight companies. Production in 1963 decreased 25 percent to 1,243,000 tons. Operating fixed plants were Edward Kraemer & Sons, Inc., Northwestern Gravel Co., Standard Building Material Co., and Swanson Aggregate, Inc. Portable plants were operated by Alexander Construction Co., Inc., Craig J. Alexander, Bituminous Surface Treating Co., and B. P. Cords. The county highway department produced and contracted for sand and gravel for road construction.

Edward Kraemer & Sons, Inc., produced crushed limestone for roadstone and agricultural limestone at its Burnsville quarry.

The Lehigh Portland Cement Co. and Northwestern States Portland Cement Co. built bulk cement distributing centers in Burnsville. The Great Northern Oil Co. completed a major expansion program at its Pine Bend refinery. Capacity was boosted to about 50,000 barrels per day. Byproduct elemental sulfur was recovered. Sulfuric acid was manufactured at the Pine Bend plant of North Star Chemicals, Inc.

Fillmore.—Iron ore shipments from Fillmore County mines were 449,000 tons, 40 percent larger than in 1962. Virtually the entire output was shipped by rail to consuming furnaces at Granite City, Ill. The Hanna Mining Co. shipped 445,000 tons of iron concentrate from its Spring Valley mine group. The company also conducted exploratory drilling. Schroeder Mining Co. shipped from its Anderson and Hinzman properties.

Crushed limestone was produced by four companies for agricultural use and road construction. Pederson Bros. (89,000 tons) operated a fixed plant at Harmony. Portable plants were operated by Hadland & Vreeman (43,000 tons) near Ostrander, Kappers Construction Co. (68,000 tons) near Fountain, and Quarve & Anderson Co. near Chatfield. Hadland & Vreeman installed a new secondary crushing plant.

Sand and gravel was produced by Bothun & Torgerson Sand & Gravel Co. and Allen Thompson at fixed plants near Lanesboro and Peterson, respectively. Hector Construction Co., Inc., sold from stockpile. The material was used for road construction, building, fill, and other purposes.

Goodhue.—Red Wing Sewer Pipe Corp. produced and used plastic fire clay to manufacture vitrified sewer pipe. The company operated three pits, the Thomforde, Pottery, and Hinsch, near Goodhue. New clay preparation, drying, and manufacturing equipment was installed. Mann Construction Co. produced crushed and broken limestone from seven quarries for road construction, riprap, building, and agricultural use. Quarve & Anderson produced crushed limestone from three quarries for road construction. The company purchased a new portable plant to increase capacity of operations. Kielmeyer Construction Co. produced roadstone from a quarry near Kenyon. Valley Limestone Co. produced road material and agricultural limestone at a fixed plant near Zumbrota. Sand and gravel was produced at six fixed and two portable plants by eight companies for building, road construction, and fill. The State and county highway departments produced and/or contracted for sand and gravel for road construction.

Hennepin.—About 3.4 million tons of sand and gravel was produced, mainly in Minneapolis suburban areas. Output was for road construction, building, fill, ice sanding, molding, and other uses. The major tonnage was produced in stationary plants. Commercial operators included Alexander Construction Co., Inc., Craig J. Alexander, Anderson Aggregates, Inc., Commercial Aggregates, Inc., Consolidated Materials Co., Jay W. Craig Co., Chas. M. Freidheim Co., Frisk Sand Co., Glacier Sand & Gravel Co., J. V. Gleason, Hedberg & Sons Co., Hopkins Sand & Gravel Co., Industrial Aggregate Co., Keller Bros. Gravel Co., Landers-Norblom-Christenson Co., Mapco Sand

& Gravel Co., The Oscar Roberts Co. and Concrete Service, Inc., fixed plant did not operate during the year. The State and county produced and/or contracted for paving sand and gravel.

Clay was produced near Minneapolis by North Central Lightweight Aggregate Co., Inc., and was used to make sintered lightweight aggregate.

Western Mineral Products Co. and Minnesota Perlite Corp. expanded crude perlite mined in Nevada and New Mexico at plants in Minneapolis. Output was sold for soil conditioning, for paint texture additive, and as lightweight aggregate in concrete and plaster. Exfoliated vermiculite was produced in Minneapolis by Western Mineral Products Co. and B. F. Nelson Mfg. Co. from crude vermiculite mined in Montana. Material was used mainly for loose fill insulation and plaster aggregate, with lesser amounts for litter, fireproofing, acoustical, and other uses.

Houston.—Botcher Contractors Co. operated a portable plant near Hokah and produced riprap, road material, and agricultural limestone. The company installed a new hammer mill to increase capacity. Hector Construction Co., Inc., operated three quarries and produced crushed limestone for roadstone and agricultural use. Shipments of paving sand were made from stockpiles by Hector Construction Co., Inc. The State highway department produced paving sand and gravel.

Itasca.—Total value of Itasca County mineral output decreased about 5 percent, chiefly because of a drop in iron-ore shipments. Mining operations continued to be affected by the low demand for conventional ores. All mines operated were open pits. About 98 percent of the usable iron-ore shipments was concentrate. Operating companies and mines from which iron ore was shipped were as follows:

Company:	*Mines*
Cleveland-Cliffs Iron Co	Canisteo, Hawkins, Hill-Trumbull, Holman-Cliffs, and Sally.
The Hanna Mining Co	Hunner, Mississippi group, Harrison group, and Patrick group.
Jessie H. Mining Co	Jessie No. 2.
Jones & Laughlin Steel Corp	Hill Annex and Lind-Greenway.
United States Steel Corp	Arcturus and Plummer.
Pickands Mather & Co	Bennett, Danube, and West Hill.

Cleveland-Cliffs Iron Co. shipped ore remaining in Hawkins mine stockpiles. The Hawkins mine was shut down in 1962. The concentrating plant and other buildings were dismantled during the 1962–63 winter. The company added an additional heavy-media feed preparation screen to the Canisteo plant and initiated changes in the Holman-Cliffs plant to improve concentrate grade. Ore from the Sally mine was treated at the Canisteo plant. Low-grade ores from Cleveland-Cliffs Iron Co. properties were tested under a cooperative program by the Federal Bureau of Mines to investigate the possibilities of using flotation for beneficiating the company's low-grade ores.

The United States Steel Corp. and The Hanna Mining Co. continued experimental research converting nonmagnetic semitaconite in kilns to artificial magnetite. The Hanna pilot plant was temporarily shut down in November following almost 3 years of extensive tests to develop a technical and economic process. United States Steel Corp. transferred its Duluth research laboratory activities to Coleraine.

The Jessie H. Mining Co. erected a fines-treating plant in conjunction with its washing plant near Coleraine. The present Jessie plant uses log washers and hydraulic classifiers to concentrate high-alumina cretaceous ores. The Jessie No. 1 mine was exhausted and the Jessie No. 2 will be the source for the fines plant.

Pickands Mather & Co. closed the Bennett mine near Keewatin, at the end of the 1963 ore season. The Bennett mine was opened in 1913 as a combination open-pit and underground operation. Production during the life of the mine was about 25 million tons. Lack of demand for the remaining marginal ore was cited as the reason for abandonment of the operation.

About 489,000 tons of sand and gravel was produced by four commercial companies and two Governmental units. Portable plants were operated by Hawkinson Construction Co., Inc., Grand Rapids; Jay W. Craig Co., Talmoon; and Megarry Bros., Effie and Swan River. Neil Baker Co. operated a fixed plant at Grand Rapids.

Colby Pioneer Peat Co. produced moss peat near Wawina. Sales were chiefly for soil conditioning.

Kanabec.—The Mora Gray quarry of Cold Spring Granite Co. was not operated in 1963. However, granite produced in previous years was finished at the company's plant in Stearns County for architectural use and monuments. Sand and gravel for building and road paving was produced in portable plants near Warman and Mora by Jay W. Craig Co. and Hallett Construction Co., respectively. The State and county highway departments produced and contracted for paving material.

Lac qui Parle.—Bellingham Granite Co. (formerly Dewar Bellingham Granite Co.) and Dakota Granite Co. quarried granite near Bellingham. The stone after processing was sold for monuments and mausoleums. Cold Spring Granite Co. and the North Star Granite Corp. quarried granite near Odessa, shipping it to finishing plants at Cold Spring and St. Cloud, respectively. The rough stone was processed into monuments and architectural stone. The Northern Quarrying Corp. quarried granite near Louisburg. Sand and gravel for building and road paving was produced by Johnson Road Co., Inc., and W. J. Stolpman. The State and county highway departments produced and/or contracted for 117,000 tons of paving sand and gravel.

Lake.—The Reserve Mining Co. Silver Bay plant shipped a record 7.7 million tons of taconite-concentrate pellets, produced from approximately 23 million tons of crude ore. Reserve's expansion program to increase capacity of the Silver Bay plant to 9 million tons of pellets per year was completed early in 1963. The first cargo of the year was loaded at Silver Bay on April 23. The final cargo left the port on December 5.

Two Harbors Aggregate Co. produced sand and gravel at a fixed plant at Two Harbors. Ulland Bros., Inc., operated portable plants at four pits. The material produced was used for building, paving, sanding, and fill. The State and county highway departments produced and contracted for 323,000 tons of sand and gravel for road construction.

Le Sueur.—The Babcock Co. quarried limestone near Kasota. Principal products were cut stone and stone veneer. A portion of the product was marketed as marble for interior trim and facings.

Silica sand was produced near Le Sueur from the Jordan Sandstone formation by Gopher State Silica, Inc., and sold for glass manufacturing, molding, oilfield fracturing, filler, and building. The Babcock Co. produced silica sand for grinding and polishing. The Glander Sand & Gravel Co. produced sand and gravel at a fixed plant near Le Sueur for paving and fill. Zarnott Construction Co. operated a fixed plant near Le Sueur, producing material for road construction. Portable sand and gravel plants were operated by Ed Swartout and Lundin Construction Co. The State and county highway departments contracted for material for road paving.

Mille Lacs.—Granite for architectural and monument use was produced near Isle by Cold Spring Granite Co. from its Diamond Grey quarry. Finishing was done at its Cold Spring plant. Mille Lacs Sand & Gravel Co. produced 15,000 tons of sand and gravel at a fixed plant near Milaca. Production was chiefly for building construction. The State and county highway departments contracted for 159,000 tons of sand and gravel for road construction.

Mower.—About 600,000 tons of sand and gravel was produced by six companies operating fixed and portable plants near Austin and Adams. Production was double that of 1962 because of increased requirements for freeway construction. The county highway department contracted for paving sand and gravel. Martin Bustad & Son produced crushed limestone at a fixed plant near Austin for roadstone and agricultural use. Osmundson Brothers operated a portable plant near Grand Meadow, producing crushed limestone mainly for road construction. Hickok Calcium White Rock Co. produced limestone near Le Roy for mineral food, flux, riprap, agricultural uses, and roadstone.

Nicollet.—New Ulm Quartzite Quarries, Inc., produced crushed quartzite at a fixed plant near New Ulm. Output was sold for concrete aggregate, riprap, refractories, poultry grit, and other uses. Sand and gravel was produced for building, paving, and other uses by three companies operating fixed plants near Courtland, St. Peter, and Judson. The county highway department contracted for 61,000 tons of paving gravel.

Olmsted.—Schroeder Mining Co. produced iron ore from the Baker, Bernard, and Partello properties near Chatfield. Most of the output was shipped by rail to consuming furnaces. Some of the ore was used for manufacturing cement. About 365,000 tons of sand and gravel was produced by three companies and one governmental unit, mostly in the vicinity of Rochester. The State and county highway departments and the city of Rochester contracted for and/or produced paving sand and gravel for road construction. Quarve & Anderson Co. produced crushed limestone from eight quarries for roadstone and agricultural use.

Otter Tail.—About 967,000 tons of sand and gravel was produced by seven companies and two governmental units. Production more than doubled 1962 output. Principal use of the sand and gravel was in road construction.

Pine.—Value of mineral production increased over threefold due to stepped-up activity in road construction. Four companies and two governmental units produced about 285,000 tons of sand and gravel. Pine City Peat Co. produced reed-sedge peat 3 miles north of Pine City and sold the material in bulk and packaged form for soil conditioning.

Polk.—Value of mineral production increased 30 percent over that of 1962, mainly owing to increased production of quicklime. The American Crystal Sugar Co. produced quicklime at Crookston and East Grand Forks. Shaft kilns were utilized with coke as fuel. An 8-percent increase in sand and gravel production was reported. About 839,000 tons were produced for building, road construction, railroad ballast, fill, and other uses. Commercial producers of sand and gravel included the Great Northern Railway Co., Mahnomen Construction Co., Northern Sand & Gravel, Inc., Spring Gravel Co., and Thorson Gravel Co. The State highway department produced paving sand and gravel, and the county highway department contracted for its needs.

Ramsey.—Arsenal Sand & Gravel Co. produced 586,000 tons of sand and gravel at its New Brighton plant for building and road purposes and fill. Cemstone Products Co. (70,000 tons) and J. W. Craig Co. (140,000 tons) operated portable plants near St. Paul and New Brighton, respectively. Output was for road construction and fill. The State and county highway departments contracted for paving sand and gravel.

Twin City Brick Co. produced clay for manufacturing building brick. Sebesta Stone Co. produced dimension limestone for flagging and rough construction. The MacArthur Co. produced exfoliated vermiculite at its St. Paul plant from crude vermiculite mined in Montana. The exfoliated product was sold for insulation, plaster, and concrete aggregate. The Koppers Co., Inc., St. Paul coke plant operated 65 ovens.

Redwood.—View Quarry Co. and Johnson Quarry Co. quarried granite near Belview for architectural and monumental purposes. Miscellaneous clay was produced near Redwood Falls by Ochs Brick & Tile Co. for processing at the company's brick plant at Springfield. Sand and gravel was produced by Chapman Gravel Co. and Walnut Washed Sand & Gravel Co. (formerly Buterbaugh Sand Co.). Production was used for road paving, fill, building, and other purposes. The county highway department produced and contracted for 245,000 tons of paving materials. The State highway department produced about 6,000 tons of paving sand and gravel.

Renville.—Cold Spring Granite Co. produced dimension granite at its Rainbow quarry and processed the rough stone at its Cold Spring plant into architectural and monumental stone. About 369,000 tons of sand and gravel was produced by five commercial operators. Operating fixed plants were Danube Washed Sand & Gravel Co. near Danube and Morton Aggregates, Inc., near Morton. The Minnesota Sand & Gravel Co. fixed plant at Belview was idle. Portable plants were operated by Duininck Bros. & Gilchrist, Fairway Construction Co., and Johnson Road Co. The county highway department produced and contracted for about 81,000 tons of paving gravel.

Rice.—About 483,000 tons of sand and gravel, 51 percent more than 1962, was produced by five commercial producers and under contract for State and county highway departments. The largest increase in use for sand and gravel was in road construction. Other uses included building and fill. Crushed limestone for roadstone, agricultural use, and riprap was produced at portable plants by Bryan Rock Products, Inc., Faribault Quarries, and Kielmeyer Construction Co. Quarries were near Northfield and Faribault.

Rock.—Jasper Stone Co., from a quartzite quarry near Jasper, produced grinding pebbles, tube-mill liners, and test blocks for rotary drill bit efficiency tests. Some stone was sold for riprap. About 377,000 tons of sand and gravel was produced, a 20-percent decrease from 1962. Producers were Pronk & Son, Hallett Construction Co., and C. H. Hatting Gravel Co., Inc., operating plants near Leota and Luverne, and the State highway department. Output was for road construction, building, fill, and other uses. The county highway department contracted for its needs.

St. Louis.—Minnesota's largest county, St. Louis, registered a 9-percent value increase in 1963. The value of its mineral output represented 74 percent of the State total. The principal reason for the value gain was a 5-percent increase in iron-ore shipments. Iron ore was the chief mineral commodity produced and accounted for 98 percent of the total county value. The greater value gain, compared to the quantity increase, reflected a greater proportion of concentrates in the total shipments from the county; 80 percent were concentrates and the remainder direct-shipping grades. St. Louis County mines supplied 77 percent of the total usable iron ore shipped from the State. Operating companies and mines shipping iron ore in 1963 were:

	Mines
Mesabi Range:	
Cleveland-Cliffs Iron Co	Wanless.
The Hanna Mining Co	Agnew No. 2-South Agnew, Douglas, Duncan, Morton-South Eddy, North Uno, Pierce group, and Weggum.
Jones & Laughlin Steel Corp	Longyear group and Schley group.
W. S. Moore Co	Mariska, Norman, and Yawkey.
North Range Mining Co	Nahma.
Oglebay Norton Co	St. James.
United States Steel Corp	Burt Stockpile No. 41, Fayal, Gilbert, Hull-Rust, Iron Range Reserve, Kosmerl, Pilotac, Rouchleau group, Sherman group, Spruce Scram Stockpile, and Stephens.
Pacific Isle Mining Co	Brunt, Iroquois, and Wacootah.
Pickands Mather & Co	Bennett Annex, Embarrass, Erie Commercial, and Mahoning.
Pittsburgh Pacific Co	Albany group, Albany L.O.S.P., Cloquet L.O.S.P. No. 3, Columbia L.O.S.P. No. 1, Lincoln, Meadow, Missabe Mountain, Wyoming, and Wyoming Annex.
Republic Steel Corp	Susquehanna.
Reserve Mining Co	Peter Mitchell.
Rhude & Fryberger	Fayal Annex, Hull-Nelson, Security, and Wade.
Snyder Mining Co	Godfrey, Webb-Sellers Triangle, and Whiteside.
E. A. Young, Inc	Minnewas.
Vermilion Range:	
United States Steel Corp	Pioneer and Soudan.
Zenith Mining Co	Zenith.

The only underground mines operating at the end of 1963 were the Pioneer and the Albany. The Godfrey, Soudan, and Zenith underground mines were idle, but shipped from stockpiles. After the final shipment from the Soudan, the United States Steel Corp. deeded the property to the State of Minnesota as a park. Total production for the 78 years the mine operated was slightly over 16 million tons of high-grade lump ore.

Shipments of taconite concentrates reached a record high. About 37 percent of the State total iron-ore output was taconite concentrates. Erie Mining Co. (Pickands Mather & Co., operating agents) produced taconite pellets throughout the year at its large-scale operations near Hoyt Lakes. The taconite pellets from its Hoyt Lakes plant were hauled 73 miles over the company-owned railroad to the company's shipping port at Taconite Harbor. Erie continued its program of design modification and improvement at its plant and began development work on a new mine near Dunka River to supplement its crude ore supply. Reserve Mining Co. mined 23.3 million tons of crude taconite at its Peter Mitchell mine near Babbitt. The crude material was crushed to about 3-inch size at the mine site and shipped over the interplant railroad to Silver Bay for final processing.

United States Steel Corp. continued to operate its taconite pilot plant near Mountain Iron. Concentrate was shipped to its Extaca plant near Virginia for agglomeration. Contracts were awarded for the engineering design of a proposed taconite-concentrating plant, with an annual capacity of 4 million tons of pellets, to be built near the existing United States Steel pilot plant. Major producing mines operated by United States Steel in St. Louis County were the Stephens, Rouchleau group, Sherman group, and Hull-Rust. The Hull-Rust was added to the shipping rolls after being idle since 1960. Hull-Rust ores were transported to the Sherman concentrator for beneficiation. Leases terminated by the company included the Fayal and Spruce near Eveleth.

The Hanna Mining Co. did not operate the Agnew No. 2-South Agnew or the Weggum in 1963. Shipments from these mines were made from stocks of concentrates at the mine plants. The company also exhausted and closed the North Uno property. Its largest producer was the Pierce group near Hibbing. A 30-cubic-yard dragline used to strip the Pierce was sold to Peabody Coal Co. This machine was the largest of its type used on the Mesabi Range.

Jones & Laughlin Steel Corp. reported the Longyear mine was exhausted at the close of the season. The corporation operated the Gilbert mine owned by United States Steel, in conjunction with its Schley group operations. North Range Mining Co. terminated its lease on the Nahma mine, although an unmined reserve remains. Snyder Mining Co. made the final ore shipment from stocks at the idle Godfrey mine. In connection with its Whiteside mine operations, the company mined ore from the Wanless and Kosmerl properties held by Cleveland-Cliffs Iron Co. and United States Steel Corp., respectively. Rhude & Fryberger dewatered and reactivated the Wade open-pit mine near Kinney. The firm terminated its leases on the idle Fayal Annex, Pearsall, and Troy mines, although some shipments were made from stocks at these mines.

Pittsburgh Pacific reported production and shipments from the following properties which were not operated during 1962: Cloquet L.O.S.P. No. 3, Columbia L.O.S.P. No. 1, Lincoln, and Wyoming Annex. Ore from these mines was treated at the Coons Pacific and Julia plants.

The Oglebay Norton Co. exhausted and closed the St. James mine. The Eveleth Taconite Co., formed by Oglebay Norton Co. and the Ford Motor Co., announced plans to start construction on a taconite-concentrating plant near Forbes in the spring of 1964. The plant will have a designed capacity of 1.5 to 2 million tons of pellets per year.

W. S. Moore Co. dropped the leases on the idle Norman and Yawkey mines, although shipments were made from stockpiles of concentrates. At the idle Mariska mine, the firm began construction of a pilot plant designed to agglomerate high-grade iron-ore concentrates by briquetting. The pilot plant is part of a joint research program on iron-ore beneficiation by W. S. Moore Co. and Northern Natural Gas Co.

American Steel & Wire Division of United States Steel Corp. produced coke and basic pig iron and steel at Duluth. One of the company's two blast furnaces was idle all year.

Universal Atlas Cement Division of United States Steel Corp. produced portland and masonry cements at its plant in Duluth. Total output increased only slightly over that of 1962. Cutler-Magner Co., also in Duluth, produced quicklime and hydrated lime. The firm was the State's only commercial producer and recorded an 8-percent increase in quantity and value for 1963.

The Zenith Dredge Co. produced crushed basalt near Duluth for roadstone and railroad ballast.

Arrowhead Peat Co. produced moss peat from company and State-owned lands near Wawina. Peat sales were primarily for use as a soil conditioner. Peat was shipped in bulk and packages.

Nine commercial companies and the State and county highway departments produced 1.8 million tons of sand and gravel from stationary and portable plants. Output was used for building and road construction, railroad ballast, fill, and other purposes.

Scott.—Crushed and broken limestone (225,000 tons) was produced at fixed plants near Shakopee and Savage by B & R Rock Products, Bryan Rock Products, Inc., and Landers-Norblom-Christenson Co. (subsidiary of J. L. Shiely Co.). Output was for agricultural use, roadstone, and asphalt filler.

About 242,000 tons of sand and gravel, a 39-percent decrease from 1962 output, was produced by five companies and the county highway department. Operating fixed plants, principally near Shakopee, were Belle Plaine Sand & Gravel, Haferman & Stark, Inc., Minnesota Quartz Co., and Shakopee Sand & Gravel. J. W. Craig Co. operated a portable plant near Belle Plaine. Output was for road construction, building, fill, sand blasting, and other uses. The State highway department contracted for paving materials.

Stearns.—Mineral output increased 16 percent in value, principally owing to increased production of dimension and crushed stone. Cold Spring Granite Co. operated five quarries near Cold Spring, St. Cloud, Rockville, and St. Joseph. The rough granite blocks were trucked to Cold Spring and St. Cloud for finishing. Output was chiefly for architectural use and monuments. Some material was

crushed at the Cold Spring plant and sold for poultry grit. Delano Granite Works, Inc., quarried granite near Rockville. Output was for monuments and architectural use. North Star Granite Corp. produced granite at its No. 4 (Gray) and No. 5 (Pink) quarries near St. Cloud. The output was processed at its St. Cloud plant and sold for monuments. Crushed granite was produced near Waite Park by Shiely-Petters Crushed Stone Co., Inc. The product was sold principally for roadstone and railroad ballast. A. C. Petters Co., Inc., produced sand and gravel at a fixed plant near St. Cloud, chiefly for use in road construction and building. The State produced 50,000 tons of paving material. The county highway department contracted for 283,000 tons of sand and gravel for paving and fill.

Steele.—Klemmer Construction Co. produced over 72,000 tons of crushed and broken limestone near Owatonna for riprap, roadstone, and agricultural use. Sand and gravel was produced in fixed plants near Owatonna and Medford by Lundin Sand & Gravel Co., Owatonna Aggregates Corp., and Medford Washed Sand & Gravel Co. The county highway department contracted for 61,000 tons of paving sand and gravel.

Washington.—About 2 million tons of sand and gravel, a 22-percent increase, was produced by eight companies and two Governmental units. Producers included Alexander Construction Co., Inc., Cemstone Products Co., Jay W. Craig Co., R. J. Jaeger Gravel Co., Moelter Construction Co., Inc., Carl Olinger, Shalander & Shaleen, and J. L. Shiely Co. The State and county highway departments produced and contracted for paving sand and gravel. Commercial material was used for building, fill, road construction, and other uses.

Bryan Rock Products, Inc., and Nienaber Contracting Co. produced crushed limestone at portable plants near Marine-on-St. Croix and Lake Elmo. J. L. Shiely Co. produced crushed limestone at a fixed plant in St. Paul Park. Products were used for roadstone, agricultural purposes, and riprap.

Winona.—Value of mineral production was $1.2 million, a 43-percent increase over that of 1962. The increase was mainly due to increased road construction activity. Dimension limestone was produced near Winona by Biesanz Stone Co., Inc., chiefly for architectural use. Crushed limestone for roadstone and agricultural use was produced at portable plants by Fred Fakler, Hector Construction Co., Inc., and Patterson Quarries, Inc., at Winona, Dresbach, and St. Charles, respectively. Winona Aggregate Co. produced sand and gravel at a dredging operation near Winona. Output was used for road construction and building. Jay W. Craig Co. operated a portable sand and gravel plant near Minnesota City. The State highway department produced and contracted for sand and gravel for highway construction.

Wright.—Delano Granite Works, Inc., operated a sawing and finishing plant at Delano, processing rough granite quarried by the company in Big Stone and Stearns Counties. The company announced an expansion program to increase facilities by one-third. The sharply increased demand for structural granite was cited as the reason for the expansion program.

Sand and gravel was produced for road construction and building use. Producers included Hanover Sand & Gravel near Hanover and Edward Schram Washed Sand & Gravel near South Haven. The county highway department contracted for 222,000 tons of road paving.

Yellow Medicine.—Dimension granite for monuments was produced near Echo by the Signet Quarry Co. Crushed and broken granite for riprap and railroad ballast was produced near Granite Falls by The Green Co., contractor for the Great Northern Railway Co. Deutz & Crow Co., Inc., produced sand and gravel for building and road construction at a fixed plant near Canby. Buster Long Construction Co. produced gravel for road paving near Hazel Run. The State and county highway departments produced and/or contracted for paving sand and gravel for highway construction and sanding.

The Mineral Industry of Mississippi

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Mississippi Geological Survey, for collecting information on all minerals except fuels.

By Nicholas A. Kendall[1] and Frederic F. Mellen[2]

VALUE of Mississippi mineral production increased to a record $219.9 million. Mineral fuels—petroleum, natural gas, and natural gas liquids—represented 89 percent of the total value.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

The New Standard Oil Co. of Kentucky refinery at Pascagoula began operating in July and attained capacity operations in November with completion of the last unit. The refinery produced motor gasoline, diesel and fuel oil, aviation gasoline, and turbine fuels. Feedstock for the refinery was about 100,000 barrels of crude per day, supplied through the 104-mile, 20-inch underwater pipeline from Ostrica,

TABLE 1.—Mineral production in Mississippi[1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	1,129	$5,742	1,235	$5,968
Natural gas—million cubic feet	170,271	32,351	176,807	31,825
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	25,891	1,616	28,757	1,755
LP gases—do	20,401	732	24,541	956
Petroleum (crude)—thousand 42-gallon barrels	55,713	154,882	[2] 58,752	[2] 162,156
Sand and gravel—thousand short tons	7,001	7,262	6,825	7,056
Stone (includes shell)—do	1,199	1,266	1,267	1,267
Value of items that cannot be disclosed: Certain nonmetals	----------	9,030	----------	8,955
Total	----------	[3] 212,881	----------	219,938

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Preliminary figure.
[3] Revised figure.

[1] Petroleum and natural gas engineer, Bureau of Mines, Bartlesville, Okla.
[2] Director, Mississippi Geological Survey, Jackson, Miss.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$124,428	1958	$151,715
1953	123,072	1959	188,496
1954	121,267	1960	198,993
1955	134,890	1961	209,037
1956	143,443	1962	207,213
1957	144,198	1963	214,438

La. The line was extended 50 miles west to connect the Bay Marchand field and other fields in offshore Louisiana where Standard Oil Co. of California has production.

Chandeleur Pipeline Co., a wholly owned subsidiary of Standard Oil Co. of Kentucky, received authorization from the Federal Power Commission to construct a 72-mile, 12-inch pipeline. About 30 million cubic feet of gas per day would be transmitted from the California Oil Co. Main Pass, Block 41 field, near the mouth of the Mississippi River, to the Pascagoula refinery for use as fuel. Cost of the project was estimated at $5,850,000.

Construction continued near Gainesville, Hancock County, on a $500 million, 13,500-acre, static testing facility for Saturn- and Nova-class rockets for the National Aeronautics and Space Administration. Over $32 million in construction contracts had been awarded at yearend; 348 workers were engaged in the work.

The initial 115-acre industrial tract of the Greenville port and industrial area was completed by the U.S. Army Corps of Engineers. The tract has access to the Mississippi River through Lake Ferguson.

Progress on the $50 million industrial canal site was reported by the Harrison County Development Commission. Two stages of the project were almost complete. The first stage is a 350-acre tract north of Gulfport with a 15-foot channel access running from Dog Key Pass at the western end of Biloxi Bay to the present new highway bridge across the Bay; the second stage is a light-industry park with an 8-foot channel at the western edge of the county north of Pass Christian. The new industrial waterway will extend inland across Harrison County from the Bay of Biloxi to the Bay of St. Louis.

Jackson County's new industrial reservoir and water supply system began operating. The $4 million transmission system has a capacity of 25 million gallons of fresh water per day and was designed to serve industries, such as the new giant Standard Oil refinery, located in the Bayou Casotte area. A 30-million-gallon-capacity reservoir near Kreole receives water pumped from the Pascagoula River for ultimate use by industrial customers. Standard Oil will use a minimum of 7 million gallons per day and may eventually need as much as 10 million gallons per day.

The Pearl River Valley Water Supply District continued construction of the $25 million Ross R. Barnett Reservoir near Jackson. When completed, the reservoir will have a capacity of 300,000 acre-feet, largest in the State.

Legislation.—The Cal-Ky Pipeline Co., owner of the 104-mile pipeline which feeds the Standard Oil Co. of Kentucky refinery at

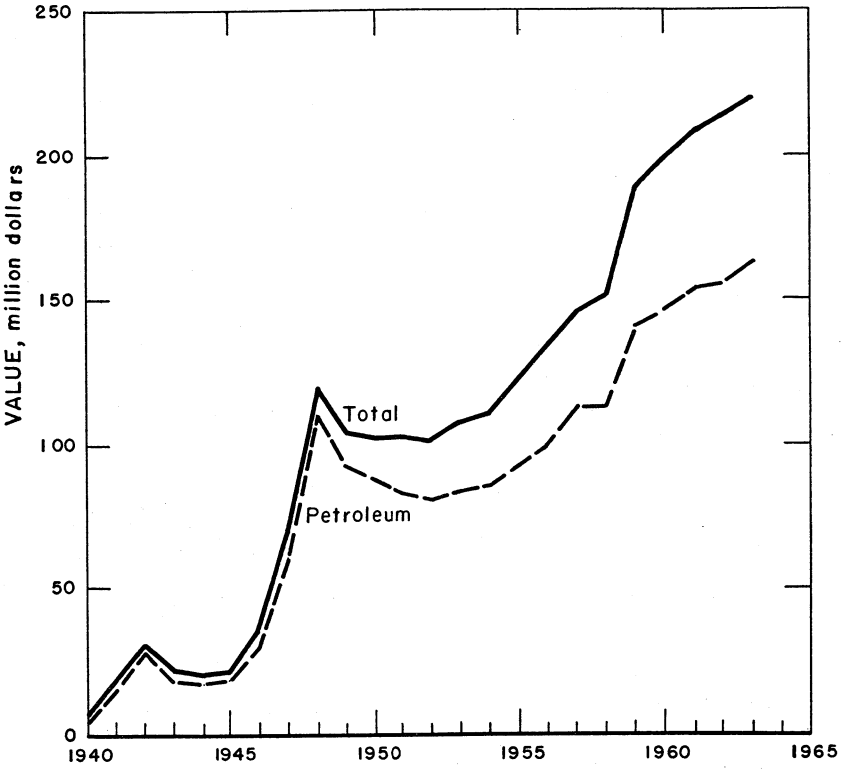


FIGURE 1.—Value of petroleum and total value of mineral production in Mississippi, 1940–63.

Pascagoula, was granted a 10-year tax exemption by the Harrison County Board of Supervisors. The action is subject to final approval by the Mississippi Agricultural and Industrial Board; a similar exemption was previously granted the refinery.

Employment and Injuries.—Overall mineral industry employment increased 3.4 percent and constituted 1.4 percent of the total labor force; wages and salaries increased 5.5 percent, according to the Mississippi Employment Security Commission. Employment in petroleum and natural gas industries increased 6 percent and constituted 86 percent of the labor force in mineral industries; wages and salaries increased 7 percent.

The substantial increase in refining personnel (table 4) resulted from the new Standard Oil Co. of Kentucky refinery at Pascagoula. Reclassification of one establishment employing about 200 persons caused a large increase in petrochemical personnel.

One worker died from injuries received when he fell off a drilling rig near Liberty. Two oilfield workers were injured when hit by a ruptured line during a fracturing operation at a Mize field well in Smith County. Decontamination was required since the fluid from the line contained highly radioactive strontium 90. Two men received burns from a flash fire at a refinery near Pascagoula.

TABLE 3.—Employment and wages in the mineral industries[1]

Activity	Average number of workers		Total wages and salaries (thousands)	
	1962	1963	1962	1963
Crude petroleum production, natural gas, and natural gas liquids	1,795	1,907	$13,377	$14,150
Oil and gasfield contract services	3,437	3,641	17,822	19,238
Sand and gravel quarries, pits, and dredges	877	792	3,481	3,268
Nonmetallic minerals	105	86	350	300
Total	6,214	6,426	35,030	36,956

[1] The Mississippi Employment Security Law covers 4 or more persons.

Source: Mississippi Employment Security Commission.

TABLE 4.—Total wage and salaried workers in petroleum production, refining, and related industries

Year	Crude petroleum and natural gas production	Petroleum refining [1]	Pipeline transportation (except natural gas)	Gas utilities	Petroleum bulk gas stations	Retail filling stations	Chemicals manufactured as byproducts of petroleum or used in refining petroleum [2]	Total
1961	5,330	401	235	2,450	(3)	2,698	94	11,208
1962	5,232	392	202	2,376	(3)	2,585	92	10,879
1963	5,548	586	178	2,292	(3)	2,608	366	11,578

[1] Employment in petroleum refineries and petrochemicals manufactured in petroleum refineries.
[2] Employment in petrochemical-manufacturing facilities located outside petroleum refineries.
[3] Data not available.

Source: Mississippi Employment Security Commission.

Water.—Water problems including long-range supply, quality, pollution, re-use, and treatment received increasing attention from Federal and State agencies and private research institutions. The Federal Bureau of Mines conducted a nationwide canvass of the mineral industry to obtain 1962 water use data. The following tables are based on results of the survey.

TABLE 5.—Water use in the mineral industry in 1962
(Million gallons)

	New water	Water recirculated	Total water use	Water discharged	Water consumed
Nonmetal mines and mills	5		5	4	1
Sand and gravel mines	6,868	3,656	10,524	6,690	178
Natural gas processing plants	201	3,103	3,304	52	149
Petroleum	768	36	804	15	753
Total	7,842	6,795	14,637	6,761	1,081

TABLE 6.—Water usage of wells drilled by rotary tools, by county, in 1962
(Barrels)

County	Number of wells	Total footage	Fresh water used	Total barrels/ foot
Adams	82	577,745	1,941,200	3.36
Amite	46	483,850	397,400	.82
Calhoun	1	9,175	13,750	1.50
Chickasaw	1	4,386	6,580	1.50
Claiborne	1	10,007	15,000	1.50
Clarke	38	160,235	304,500	1.90
Clay	3	19,483	19,500	1.00
Copiah	1	13,219	19,800	1.50
Covington	12	112,071	224,000	2.00
Forrest	8	75,643	52,000	.69
Franklin	43	318,864	430,636	1.35
George	2	21,057	31,600	1.50
Greene	2	25,026	37,500	1.50
Harrison	1	12,223	18,300	1.50
Hinds	4	30,807	46,200	1.50
Holmes	1	6,035	9,000	1.49
Issaquena	1	7,974	1,800	.23
Jasper	10	69,972	105,000	1.50
Jefferson	22	204,418	556,050	2.72
Jefferson Davis	1	14,024	21,000	1.50
Jones	36	388,978	700,015	1.80
Kemper	1	14,300	84,000	5.87
Lamar	13	126,867	190,300	1.50
Leake	1	4,873	7,300	1.50
Lincoln	25	268,136	388,600	1.45
Madison	9	67,419	146,300	2.17
Marion	22	250,661	371,000	1.48
Monroe	11	43,658	65,500	1.50
Newton	1	8,704	13,050	1.50
Pearl River	13	122,668	61,300	.50
Perry	2	20,519	20,500	1.00
Pike	25	276,247	255,960	.93
Pontotoc	1	2,458	2,500	1.02
Rankin	2	25,046	32,600	1.30
Scott	2	12,026	15,600	1.30
Simpson	8	102,067	388,500	3.81
Smith	15	179,061	102,800	.57
Stone	1	10,208	10,200	1.00
Tate	1	3,586	3,600	1.00
Tunica	1	6,105	9,150	1.50
Walthall	42	442,671	301,100	.68
Wayne	41	415,790	1,063,690	2.56
Wilkinson	34	266,023	167,600	.63
Yalobusha	1	3,896	5,850	1.50
Yazoo	18	151,641	212,250	1.40
Total	606	5,389,822	8,870,081	1.65

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Values of natural gas liquids and crude petroleum increased to new records.

Mississippi again ranked ninth among the oil-producing States. The five leading petroleum-producing counties were Pike, Adams, Lincoln, Jones, and Jasper, in descending order.

Total drilling activity was up 28 percent, compared with a national decrease of 6 percent. Average depth of all holes drilled was 8,474 feet, 464 feet less than in 1962; total footage drilled increased from 5.4 million feet to 6.2 million feet, according to the Oil and Gas Journal. Secondary recovery scored further gains, with waterflooding operations in McComb and Little Creek oilfields. Larco Drilling Co. started injecting water into the Lower Tuscaloosa formation of Summit field in Pike County, as approved by the Mississippi Oil and Gas Board.

Humble Oil & Refining Co. and Hess Oil & Chemical Corp. had a pilot waterflood in operation in the Eutaw formation of the East Eucutta field, Wayne County.

TABLE 7.—Oil and gas well drilling and total crew-weeks spent in geophysical oil and gas prospecting in 1963, by counties

County	Drilling							Geophysical, crew-weeks
	Proved field wells			Exploratory wells			Total	Reflection Seismograph
	Oil	Gas [1]	Dry	Oil	Gas	Dry		
Adams	35		59	5		48	147	9
Amite	11	1	14	1		11	38	2
Bolivar								2
Calhoun						1	1	3
Chickasaw					1		1	
Claiborne			1			2	3	7
Clarke	18		3			12	33	38
Clay						1	1	3
Copiah						1	1	
Covington	2		2			1	5	21
Forrest		6	2				8	7
Franklin	34		36	3		42	115	2
George						1	1	28
Greene	2			2		2	6	85
Grenada								1
Hancock						1	1	3
Harrison						1	1	12
Hinds	4		2			3	9	24
Holmes								14
Issaquena						1	1	7
Itawamba		3	1				4	
Jackson						1	1	23
Jasper		1	3			7	11	49
Jefferson	6	1	5			19	31	
Jefferson Davis		1					1	1
Jones	23		8	1		7	39	70
Lamar	4		2			1	7	1
Lauderdale								2
Lawrence		1					1	
Leake								10
Lincoln	12		9	1		1	23	
Lowndes						1	1	3
Madison			1			6	7	45
Marion	5	5	3			1	14	2
Monroe						1	1	8
Newton								6
Noxubee								7
Oktibbeha						1	1	3
Pearl River		4	1			2	7	
Perry						1	1	38
Pike	6		19	1	1	11	38	
Pontotoc						2	2	
Rankin	3		6			5	14	9
Scott						2	2	25
Sharkey			2			3	5	
Simpson	2		4			4	10	69
Smith	19		4	2		8	33	85
Stone								5
Sunflower								5
Tishomingo						1	1	
Walthall	25	3	17			3	48	2
Warren						1	1	36
Washington								8
Wayne	15		7			17	39	197
Webster								4
Wilkinson	15		17			27	59	32
Winston								2
Yazoo	17		3			3	23	33
Total:								
1963	258	26	231	16	2	264	797	1,048
1962	200	34	158	16	1	213	622	909

[1] Includes condensate.

Source: Mississippi State Oil & Gas Bulletin (Jackson, Miss.). V. 63, No. 1, March 1963, through No. 12, February 1964.

Eighteen new field discoveries were Oakland, West Carthage Point, Glasscock Towhead, Glasscock Island, and Quitman Bayou in Adams County; Pumpkin Patch in Amite County; Thorn (gas) in Chickasaw County in the Black Warrior basin; Dry Creek, Franklin, and Buckley in Franklin County; Avera and North Sand Hill in Greene County; Blackburn in Jones County; North Sweetwater in Lincoln County; East Summit (gas) and West Lazy Creek in Pike County; and South Center Ridge and Bienville Forest in Smith County. Of these, Avera loomed as the most important discovery because it contained three reservoirs.

An important paper, "Regional Stratigraphy of the Midway and Wilcox in Mississippi", was published by the Mississippi Geological Survey as part of its Bulletin 102, "Mississippi Geologic Research Papers, 1963." This paper was expected to encourage exploration efforts in the State.

The Mississippi-Alabama Division of the Midcontinent Oil & Gas Association formed a standing committee on water pollution after the issue was raised by the Mississippi Oil and Gas Board; the Committee was to study the issue in Mississippi.

According to the "Mississippi State Oil & Gas Bulletin," as of December 31, 1963, the State had 252 oil pools and 50 gas pools producing in 229 fields; the 3,553 wells capable of producing represented a net increase of 45 wells over the 1962 total.

TABLE 8.—Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

	Proved reserves, Dec. 31, 1962	Changes in proved reserves, due to extensions and new discoveries in 1963	Proved reserves, Dec. 31, 1963 (production was deducted)	Change from 1962, percent
Crude oil—thousand barrels	388,383	53,743	384,909	—1
Natural gas liquids [1]—do	36,015	120	33,148	—8
Natural gas—million cubic feet	2,735,845	—54,656	2,481,627	—9

[1] Includes condensate, natural gasoline, and LP gases.

Source: American Gas Association, American Petroleum Institute, and Canadian Petroleum Association' Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas. V. 18, Dec. 31, 1963, pp. 11–12, 23.

Natural Gas.—Marketed production of natural gas was 177 billion cubic feet valued at $31.8 million based on an average unit price of 18 cents per thousand cubic feet, compared with 19 cents in 1962. Five counties—Forrest, Adams, Jefferson Davis, Marion, and Pearl River—supplied 72 percent of the State's natural gas production.

Reserves dropped 254,218 million cubic feet and represented 0.9 percent of the national reserves (1 percent in 1962). Ratio of reserves to yearly production was 14:1 (16:1 in 1962).

Two new gasfields were discovered, one in Pike County and one in Chickasaw County. Geologically, Chickasaw County is in the Black Warrior basin. Fields in this basin produce predominantly gas, which finds a ready intrastate market in the several local plants which produce brick, bentonite, fuller's earth, and other clay-de-

rived products. Geophysical activity in the basin in 1963 amounted to only 14 crew-weeks, all reflection seismograph.

Mississippi Valley Gas Co. had a working storage capacity of 782 million cubic feet of gas in the Amory field of Monroe County; United Gas Pipe Line Co. was capable of storing 4,850 million cubic feet in formations of the Jackson Dome, Rankin and Hinds Counties. At yearend, the State's gas storage capacity totaled 5,632 million cubic feet.

TABLE 9.—Marketed production of natural gas [1]

Year	Million cubic feet	Value (thousands)	Year	Million cubic feet	Value (thousands)
1954–58 (average)	163,772	$17,046	1961	172,543	$32,093
1959	162,095	25,125	1962	170,271	32,351
1960	172,478	32,426	1963	176,807	31,825

[1] Comprises gas either sold or consumed by producers, including losses in transmission, amounts added to storage, and increases in gas pipelines.

Natural Gas Liquids.—Natural gas liquids output increased 15 percent in volume and value; the average price, 5.1 cents per gallon, was the same as in 1962.

Marathon Oil Co. completed a gasoline plant in the Maxie field of Forrest County. Input capacity was 60 million cubic feet per day; output was 32,255 gallons per day of combined gasoline and liquefied petroleum gases.

Reserves of natural gas liquids dropped 2,867,000 barrels, according to the American Gas Association, and constituted 0.4 percent of the national reserves (0.5 percent in 1962). Ratio of reserves to yearly production dropped from 33 to 1 in 1962 to 26 to 1 in 1963.

Shell Oil Co. increased output of its gasoline plant in Little Creek field of Pike County by 31 percent. Humble Oil & Refining Co. started constructing a gasoline plant in Sandy Hook field of Marion County; completion was scheduled for March 1964. Processing capacity will be 20 million cubic feet per day and liquids recovery, 1,850 gallons per day.

Total capacity of the State's natural gas processing and cycling plants was 433.2 million cubic feet per day, an increase of 15 percent over that of 1962, according to the Oil & Gas Journal.

TABLE 10.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	25,181	$1,679	11,496	$496	36,677	$2,175
1959	23,207	1,495	8,141	465	31,348	1,960
1960	23,648	1,552	10,151	564	33,799	2,116
1961	25,135	1,625	15,510	700	40,645	2,325
1962	25,891	1,616	20,401	732	46,292	2,348
1963	28,757	1,755	24,541	956	53,298	2,711

According to the Oil & Gas Journal, solution caverns in a Forrest County salt dome contained the following fuels as of October 1963: Propane, 986,000 barrels; butane, 300,000 barrels; and LP gases, 1,612,000 barrels.

Petroleum.—Production of crude oil increased 6 percent over the 1962 level; value increased 5 percent to $162 million at an average unit value of $2.76 per barrel, compared with $2.78 per barrel in 1962. The yearly production was within 0.3 percent of demand as indicated by the Federal Bureau of Mines (table 12). Pike, Adams, Lincoln, Jones, and Jasper Counties supplied about 53 percent of the State's crude oil production.

Discovery of 18 new fields was highest since 1952, when a record 20 fields were discovered.

A milestone in Mississippi oil history was reached with the first oil production from the Smackover-Jurassic formation in Mississippi. The discovery well, opening the Bienville Forest field in the northeast corner of Smith County, encountered a 305-foot section of porosity at 14,141 feet. The top 35 feet of this section was oil saturated and produced 390 barrels of 40° API gravity oil per day. This quickly stimulated a brisk lease play along a northwest-southeast trend.

Reserves of crude oil in Mississippi dropped 3,474,000 barrels, according to the American Petroleum Institute; this constituted 1.2 percent of the national reserves, unchanged from 1962. Ratio of reserves to yearly production dropped from 7.0:1 in 1962 to 6.6:1.

TABLE 11.—Crude petroleum production

(Thousand 42-gallon barrels and thousand dollars)

Year	Production	Value	Year	Production	Value
1954–58 (average)	38,248	$100,945	1961	54,688	$154,220
1959	49,620	140,921	1962	55,713	154,882
1960	51,673	146,235	1963 [1]	58,752	162,156

[1] Preliminary figures.

TABLE 12.—Crude petroleum production, indicated demand, and stocks in 1963, by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Mississippi
January	4,897	4,545	2,885
February	4,572	4,902	2,555
March	5,005	4,626	2,934
April	4,805	5,040	2,699
May	4,975	5,137	2,537
June	5,098	5,104	2,531
July	4,484	4,639	2,376
August	4,964	5,112	2,228
September	5,063	4,910	2,381
October	5,253	5,044	2,590
November	4,736	5,027	2,299
December	4,900	4,848	2,351
Total:			
1963	[1] 58,752	58,934	----------
1962	55,713	55,753	----------

[1] Preliminary figure.

TABLE 13.—Crude petroleum production by fields[1]

(Thousand 42-gallon barrels)

Field	1959	1960	1961	1962	1963[2]
Baxterville	5,801	5,901	5,949	5,808	5,823
Bolton	1,369	1,457	1,136	1,127	1,256
Brookhaven	1,928	1,924	1,571	1,498	1,545
Bryan	1,222	2,487	3,391	2,068	2,017
Cranfield	805	1,099	901	905	863
Diamond	1,040	1,166	924	751	640
Eucutta	1,533	1,363	1,261	1,151	1,088
Heidelberg	3,262	3,302	3,974	3,737	3,620
La Grange and South	1,755	1,453	1,471	1,322	1,234
Little Creek	5,460	5,669	6,431	5,384	6,107
Mallalieu	761	601	562	596	583
McComb		2,533	2,949	4,383	4,482
Pistol Ridge Maxie	1,207	1,000	651	736	762
Raleigh	2,138	2,157	1,820	1,392	1,573
Soso	4,695	3,901	3,418	2,998	2,643
Tinsley	3,421	3,234	2,991	2,835	2,855
Yellow Creek	1,292	1,170	1,222	1,492	1,409
Other fields[3]	11,931	11,256	14,066	17,530	20,252
Total	49,620	51,673	54,688	55,713	58,752

[1] Based on Oil & Gas Journal data adjusted to Bureau of Mines total.
[2] Preliminary figures.
[3] Bureau of Mines data.

In 1963, the National Stripper Well Association classified 255 wells as stripper wells in 1962. They represented 7 percent of the producing oil wells and a little over 1 percent of the State's 1962 reserves.

Approximately 15 percent (16 percent in 1962) of the total crude petroleum produced was refined in 3 of the State's 4 plants; total capacity of the 3 plants increased 6 percent to 29,900 barrels per stream day. The new Standard Oil Co. of Kentucky refinery at Pascagoula increased the State's refining capacity to 134,900 barrels per stream day, but none of its 105,000-barrel-per-stream-day capacity was available for Mississippi crude oil. The 19,700-barrel-per-stream-day Black Creek refinery of Pontiac Eastern Corp. near Purvis, Lamar County, was sold to Gulf Oil Corp. A new subsidiary, Mississippi Gulf Refining Co., will operate the plant with no planned major changes. Gulf Oil Corp. was chief supplier and purchaser of the refinery's products.

Ashland Oil & Refining Co. purchased the Humble Pipeline Co.'s pipeline system in southwest Mississippi.

The Federal Bureau of Mines published a report[3] containing mineral analyses and electrical resistivity measurements of 303 representative samples of oilfield brines from 21 oil-producing counties in Mississippi.

Petrochemicals.—Thiokol Corp. was building a fluoro-carbon-resin plant at Moss Point, Jackson County, near Pascagoula. The resin is to be used for gaskets, packings, seals, O-rings, bearings, coatings, and electronic equipment. The company expected to have samples available late in 1963.

Hooker Chemical Co. expanded its facilities at its Columbus plant because of an anticipated increase in the demand for ammonium perchlorate, a chemical used as an oxidizer in solid fuel missiles.

[3] Hawkins, M. E., O. W. Jones, and C. Pearson. Analyses of Brines From Oil-Productive Formations in Mississippi and Alabama. BuMines Rept. of Inv. 6171, 1963, 22 pp.

NONMETALS

Cement.—Production of portland cement decreased 3 percent; output of masonry cement dropped 4 percent. Mississippi Valley Portland Cement Co. expanded the kiln capacity of its wet-processing plant at Redwood, Warren County, from 800,000 barrels to 2 million barrels annually.

TABLE 14.—Shipments of portland cement to Mississippi consumers

Year	Mississippi (thousand barrels)	Change, percent	
		In Mississippi	In United States
1954–58 (average)	2,116		
1959	3,072	+11	+9
1960	3,324	+8	−7
1961	3,603	+8	+3
1962	3,704	+3	+3
1963	3,999	+8	+5

Clays.—Clay production was 9 percent over that of 1962, establishing a record for the 4th consecutive year. Gains were reported in quantities of miscellaneous clay, bentonite, fuller's earth, and fire clay sold or used. Total tonnage of miscellaneous clay, used for manufacturing heavy clay products and lightweight aggregate, increased 12 percent and constituted 59 percent of the State's clay production. Bentonite production increased 1 percent over that of 1962. Fire clay production increased 11 percent. Ball clay was produced in Panola County.

TABLE 15.—Clays sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Bentonite		Ball clay, fire clay, and fuller's earth		Miscellaneous clay		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	206	$2,274	88	$919	319	$323	613	$3,516
1959	200	2,494	117	1,138	430	432	747	4,064
1960	238	2,900	181	1,287	598	599	1,017	4,786
1961	228	2,836	226	1,547	650	651	1,104	5,034
1962	276	3,429	207	1,666	646	647	1,129	5,742
1963	280	3,480	230	1,761	725	727	1,235	5,968

The Mississippi Geological Survey published Bulletin 99, "Attala County Mineral Resources," containing a section on ceramic tests and a discussion of the clay deposits and the present clay industry. The tests indicated industrial possibilities for a wide variety of products such as lightweight aggregates; heavy clay products including sewer pipe, brick, tile, and similar items; bonding clay for possible use in foundry molding sand; and ball clay suitable as a major ingredient in high-grade commercial pottery. Negotiations between the local Industrial Development Corp. and ceramic industries, concerning development of Attala County clay resources, were underway.

H. K. Porter Co., Inc., expanded its basic refractories plant at Pascagoula. The $675,000 program increased plant capacity by 25 percent. The plant was constructed in 1958 at a cost of $12 million to manufacture basic brick and specialties.

Ceramic wall tile was produced at the new Gulf States Ceramic Corp. plant at Houston, Chickasaw County; the production line and processes for the first glazed wall-tile unit were completed. The plant employed 60 people.

Tri-State Brick & Tile Co., Jackson, announced a $500,000 expansion of its plant, which would increase daily brick production from 96,000 to 160,000 and employ an additional 25 persons.

W. S. Dickey Clay Manufacturing Co. planned enlargement of the circular tunnel kiln at its Meridian plant, increasing production capacity of 5-foot-long pipe by 20 percent. Atlas Tile & Brick Co. announced a $100,000 expansion at its Shuqualak plant in Noxubee County, which would increase production from 60,000 to 75,000 brick per day. Employment would increase to 60 persons.

The Mississippi Geological Survey Bulletin 97, "Mississippi Geologic Research Papers—1962," contains an article on "Economic Potential of Alumina-rich Clays and Bauxite in Mississippi." This summarizes the available information on these important industrial resources.

Magnesium Compounds.—H. K. Porter Co., Inc., at Pascagoula continued production of magnesium compounds at about the same level as in 1962. Magnesium-bearing lime, made from dolomite mined in Alabama, was used in the process.

Potash.—The new $8 million nitrate of potash plant at Vicksburg is now in full production, according to an announcement by Southwest Potash Division of American Metal Climax, Inc., owners of the facility. Development of the plant processes and construction of the plant required more than 6 years. The plant produces nitrate of potash by a chemical reaction between muriate of potash (from the company's mines in New Mexico) and nitric acid. In addition, the plant produces liquid chlorine and plans to produce an industrial grade of potassium nitrate.

Salt.—The Atomic Energy Commission completed an access shaft and a ventilation shaft at Tatum salt dome, Lamar County, for its Project Dribble, preparatory to mining a 95-foot spherical cavity in the main salt body. Both shafts had to be abandoned owing to water intrusion and casing failure, but work and planning continued. Project Dribble calls for detonating nuclear devices of varying strengths to assist in seismic research.

Sand and Gravel.—Sand and gravel output decreased 3 percent in tonnage and in value. Production was reported from 23 of the State's 82 counties; leading producers in order of value were Forrest, De Soto, Adams, Copiah, Washington, and Hinds Counties. These six counties produced 50 percent of the tonnage and 53 percent of the value

Jahncke Service, Inc., of New Orleans, La., dredged glass sand offshore Harrison County to use in making automobile glass. The operation ceased in midsummer when the dredge was moved to Louisiana waters to mine glass sand within 25 miles of the company processing plant.[4]

[4] Pit and Quarry. V. 56, No. 11 May 1964, p. 78.

TABLE 16.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	5,065	$4,428	555	$407	5,620	$4,835
1959	6,921	7,199	599	544	7,520	7,743
1960	6,068	5,522	113	46	6,181	5,568
1961	5,536	5,314	384	589	5,920	5,903
1962	6,394	6,336	607	926	7,001	7,262
1963	6,306	6,266	519	790	6,825	7,056

TABLE 17.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	847	$660	902	$766
Paving	1,113	922	863	738
Other [1]	74	153	211	207
Total	2,034	1,735	1,976	1,711
Gravel:				
Building	1,377	1,532	1,719	1,888
Paving	2,767	2,925	2,325	2,498
Other [2]	216	144	286	169
Total	4,360	4,601	4,330	4,555
Total sand and gravel	6,394	6,336	6,306	6,266
Government-and-contractor operations:				
Sand: Paving	299	303	280	272
Gravel: Paving	308	623	239	518
Total sand and gravel	607	926	519	790
Grand total	7,001	7,262	6,825	7,056

[1] Includes other construction and industrial and ground sand.
[2] Includes railroad ballast, fill, and miscellaneous gravel.

TABLE 18.—Sand and gravel production in 1963, by counties

County	Short tons	Value	County	Short tons	Value
Amite	1,350	$540	Tate	4,611	$2,059
Bolivar	54,440	70,772	Warren	8,288	9,944
Harrison	133,637	120,055	Wilkinson	3,800	1,520
Lowndes	503,454	307,588	Yazoo	60,000	24,600
Monroe	312,131	254,150	Other counties [1]	5,307,934	5,924,230
Perry	326,847	297,139			
Rankin	108,508	43,403	Total	6,825,000	7,056,000

[1] Includes Adams, Clay, Copiah, De Soto, Forrest, Hinds, Holmes, Panola, Pearl River, Tishomingo, Washington, and Yalobusha Counties, combined to avoid disclosing individual company confidential data. Undistributed amounts from various counties are also included.

Tests reported in the Mississippi Geological Survey Bulletin 99 indicate that certain sands in Attala County can be beneficiated for use in making amber glass and green glass. Also, with further benefication, some of these sands possibly could be used in making the better grades of ordinary glass and flint glass.

Stone.—Offshore recovery of oyster and clam shell in Harrison County ceased when the dredge doing the work was converted to a sand dredge.

Sulfur.—Tonnage and value of recovered sulfur declined 47 percent from those of 1962. Sulfur was recovered from refinery gases at the Mississippi Gulf Refining Co. refinery near Purvis, Lamar County.

A small pilot plant of National Sulphur Co. operated at a two-well pool of Humble Oil & Refining Co. in the Loring field in Madison County. The plant was attempting to recover sulfur from Smackover gas, containing approximately 85 percent carbon dioxide.

METALS

Iron Ore.—The Mississippi Geological Survey published Bulletin 101 titled "An Investigation of Mississippi Iron Ores," the publication included a chapter on manganese deposits in the State.

Titanium Dioxide.—American Potash & Chemical Corp. broke ground for its new titanium dioxide plant adjacent to the company's sodium chlorate and manganese plants near Hamilton, Monroe County. The plant will cost $13.5 million and have an initial capacity of 25,000 tons per year, later to be increased to 50,000 tons. It will process rutile ore from Australia by the chloride process. The plant is expected to be completed by March 1965.

REVIEW BY COUNTIES

Only counties with significant mineral production are discussed in the following section. Additional details are presented in table 19.

Adams.—The county ranked second in total value of minerals produced, petroleum and natural gas production. About 17 percent of the State's natural gas and 10 percent of its crude oil came from Adams County. Five new oilfields, Oakland, West Carthage Point, Glasscock Towhead, Glasscock Island, and Quitman Bayou, were discovered as the result of exploratory well drilling. The county ranked third in value of sand and gravel produced and accounted for about two-thirds of the State's regenerated lime production.

Clay.—Near Cedar Bluff, the Division of Lime, Mississippi Department of Agriculture, produced agricultural limestone from open pits. West Point Gravel Co. produced washed sand and gravel for highway and building construction.

De Soto.—The county ranked second in value of sand and gravel produced.

Forrest.—The county led in natural gas production, producing about 18 percent of the State's natural gas. The county ranked first in quantity and value of sand and gravel production. Clay for making face brick and structural tile was mined by Hattiesburg Brick Works.

TABLE 19.—Value of mineral production in Mississippi, by counties [1]

County	1962 [2]	1963	Minerals produced in 1963 in order of value
Adams	$25,017,397	$22,778,365	Petroleum, natural gas, sand and gravel, natural gas liquids.
Alcorn	(3)	(3)	Clays.
Amite	5,480,161	4,870,236	Petroleum, natural gas, sand and gravel.
Attala	(3)	(3)	Clays.
Bolivar	63,677	70,772	Sand and gravel.
Carroll	(3)	(3)	Clays.
Chickasaw	18,190	14,802	Natural gas, clays.
Clarke	1,389,319	1,371,047	Petroleum, natural gas.
Clay	605,651	446,811	Natural gas, sand and gravel, petroleum, natura gas liquids.
Copiah	(3)	(3)	Sand and gravel.
Covington	908,331	1,392,849	Petroleum, natural gas.
De Soto	(3)	(3)	Sand and gravel.
Forrest	9,601,675	9,314,498	Natural gas, petroleum, sand and gravel, natura gas liquids, clays.
Franklin	3,535,701	4,508,477	Petroleum, natural gas.
Greene	----------	255,108	Do.
Hancock	509,540	262.777	Natural gas, petroleum.
Harrison	(3)	120,055	Sand and gravel.
Hinds	4,317,469	4,342,247	Petroleum, sand and gravel, clays, natural gas.
Holmes	351,240	(3)	Sand and gravel.
Itawamba	(3)	482,577	Clays, natural gas.
Jackson	(3)	(3)	Lime, magnesium compounds.
Jasper	15,192,237	14,194,470	Petroleum, natural gas, clays.
Jefferson	4,460,359	3,754,990	Petroleum, natural gas.
Jefferson Davis	2,907,312	5,296,110	Natural gas, petroleum.
Jones	14,739,858	16,291,577	Petroleum, natural gas, natural gas liquids, clays.
Lamar	11,730,454	13,454,631	Petroleum, natural gas.
Lauderdale	10,000	107,366	Clays.
Lawrence	----------	707	Petroleum, natural gas.
Lee	(3)	(3)	Clays.
Leflore	15,000	----------	
Lincoln	15,583,070	16,390,960	Petroleum, natural gas, natural gas liquids, clays.
Lowndes	436,915	336,188	Sand and gravel, clays.
Madison	569,679	495,799	Petroleum, natural gas.
Marion	6,446,621	7,345,886	Natural gas, petroleum, natural gas liquids.
Marshall	(3)	(3)	Clays.
Monroe	3,158,687	3,151,877	Clays, natural gas, sand and gravel, petroleum.
Noxubee	170,000	(3)	Clays.
Panola	(3)	881,962	Clays, sand and gravel.
Pearl River	3,997,413	4,455,865	Natural gas, petroleum, sand and gravel, clays.
Perry	321,996	360,133	Sand and gravel, petroleum.
Pike	26,189,900	27,827,340	Petroleum, natural gas liquids, natural gas.
Pontotoc	8,300	4,800	Clays.
Prentiss	3,800	8,525	Do.
Rankin	5,751,231	5,808,555	Cement, stone, petroleum, sand and gravel, natural gas.
Scott	35,554	16,816	Petroleum.
Sharkey	1,953	1,058	Do.
Simpson	5,744,548	4,228,959	Petroleum, natural gas.
Smith	8,042,240	9,168,504	Petroleum, clays, natural gas, stone.
Sunflower	(3)	(3)	Clays.
Tate	----------	2,059	Sand and gravel.
Tippah	(3)	(3)	Clays.
Tishomingo	(3)	(3)	Sand and gravel.
Walthall	5,037,002	7,463,921	Petroleum, natural gas.
Warren	(3)	(3)	Cement, stone, sand and gravel.
Washington	----------	(3)	Sand and gravel.
Wayne	9,359,657	9,994,311	Petroleum, natural gas.
Wilkinson	1,510,928	2,485,102	Petroleum, sand and gravel, natural gas.
Yalobusha	(3)	(3)	Sand and gravel.
Yazoo	8,593,098	9,061,604	Petroleum, sand and gravel, natural gas.
Undistributed	11,064,837	7,117,304	
Total	212,881,000	219,938,000	

[1] The following counties were not listed because no production was reported: Benton, Calhoun, Choctaw, Claiborne, Coahoma, George, Grenada, Humphreys, Issaquena, Kemper, Lafayette, Leake, Montgomery, Neshoba, Newton, Oktibbeha, Quitman, Stone, Tallahatchie, Tunica, Union, Webster, and Winston.

[2] Revised figures.

[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed".

Franklin.—Exploratory drilling of 45 wells resulted in discovery of Dry Creek, Franklin, and Bunckley oilfields.

Greene.—Four exploratory wells resulted in discovery of Avera and North Sand Hill oilfields; Avera oilfield contained three productive reservoirs.

Hancock.—The National Aeronautics and Space Administration continued construction of its $500 million test center near Gainesville for static testing of Saturn- and Nova-class launch vehicles.

Harrison.—Jahncke Service, Inc., ceased dredging glass sand from tidelands as of midsummer.

Hinds.—The county retained its lead in quantity of miscellaneous clay mined and used for manufacturing lightweight aggregates, face brick, and other clay products and ranked sixth in value of sand and gravel produced.

Jackson.—The $125 million Standard Oil Co. of Kentucky refinery at Pascagoula started operating at full capacity in November. Input capacity was 105,000 barrels per stream day and 100,000 barrels per calendar day.

Lime produced at the H. K. Porter Co., Inc., plant at Pasagoula, from Alabama dolomite and shell, accounted for about one-third of the State's lime output. The plant also produced magnesium compounds.

Jefferson Davis.—The county reached third place in production of natural gas and accounted for 14 percent of the State's production.

Jones.—The county ranked fourth in total value of minerals produced. Exploratory drilling resulted in discovery of Blackburn oilfield. The county ranked fourth in oil production, accounting for 9 percent of the State's production.

Lamar.—Development drilling added four oil wells to existing fields. Sulfur production by Mississippi Gulf Refining Co. at its refinery near Purvis was 47 percent below the 1962 output. Storage of LP gas products in caverns in a salt dome continued. The county ranked sixth in production of both oil and gas.

Lincoln.—The county ranked third in total mineral production value and third in oil production, accounting for about 10 percent of the total petroleum. Exploratory drilling resulted in discovery of North Sweetwater oilfield.

Marion.—The county, fourth in natural gas production, produced approximately 12 percent of the State total.

Marshall.—Holly Springs Brick & Tile Co. and Southern Brick & Tile Co. mined fire clay and miscellaneous clay from open pits to make building brick. The county ranked seventh in production value of clay.

Monroe.—The county retained its lead in value of clay production, accounting for 36 percent of the State total. Bentonite was mined from open pits and processed for mold making, absorbing, filtering, and decolorizing.

American Potash & Chemical Corp. broke ground for its new titanium dioxide plant, which will process rutile from Australia.

Panola.—Substantial production of ball clay for glass-refractory use and washed sand and gravel for highway and structural uses was reported.

Pearl River.—The county continued to rank fifth in natural gas production, accounting for 10 percent of the gas produced in Mississippi.

Pike.—The county led in total value of minerals and in petroleum production, accounting for 16 percent of the State's oil. Exploratory drilling opened West Lazy Creek oilfield and East Summit gasfield.

Rankin.—Exploratory drilling resulted in five dry holes; development drilling resulted in three oil wells and six dry holes. Marquette Cement Manufacturing Co., one of the State's two cement plants, produced portland and masonry cement at Brandon.

Smith.—Exploratory drilling resulted in discovery of South Center Ridge and Bienville Forest oilfields. Bienville Forest was the first oilfield in the State to produce from the Smackover formation. Development drilling, mostly in the Mize multipay field which had been discovered in 1962, brought in 19 oil producers; 4 holes were dry.

Tippah.—The county ranked second in value of clay produced and was again the State's only producer of fuller's earth.

Warren.—Mississippi Valley Portland Cement Co., one of the State's two cement plants, produced portland and masonry cement.

Wayne.—The county shared fifth place in drilling activity with Jones County; it was seventh in oil production. Development drilling added 15 oil wells to existing fields, mostly in the newly discovered, multipay Wausau field.

Yazoo.—The county ranked eighth in petroleum production. Mississippi Chemical Corp. completed construction of additional port, warehouse, and storage facilities at Yazoo City.

747-416—64——40

The Mineral Industry of Missouri

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Division of Geological Survey and Water Resources, Department of Business and Administration of Missouri, for collecting information on all minerals except fuels.

By A. Kuklis [1] and William C. Hayes [2]

MINERAL PRODUCTION in Missouri was valued at $159 million; it was the second highest on record for the State and was exceeded only in 1956 ($163.7 million). Increased output of coal, lead, lime, sand and gravel, and stone more than offset decreased production of barite, cement, iron, and clay. Production of nonmetals and related products dominated the mineral industry and accounted for $123.9 million, or 78 percent of the total value. The six principal mineral commodities in order of value were stone, cement, lead, lime, coal, and sand and gravel.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real

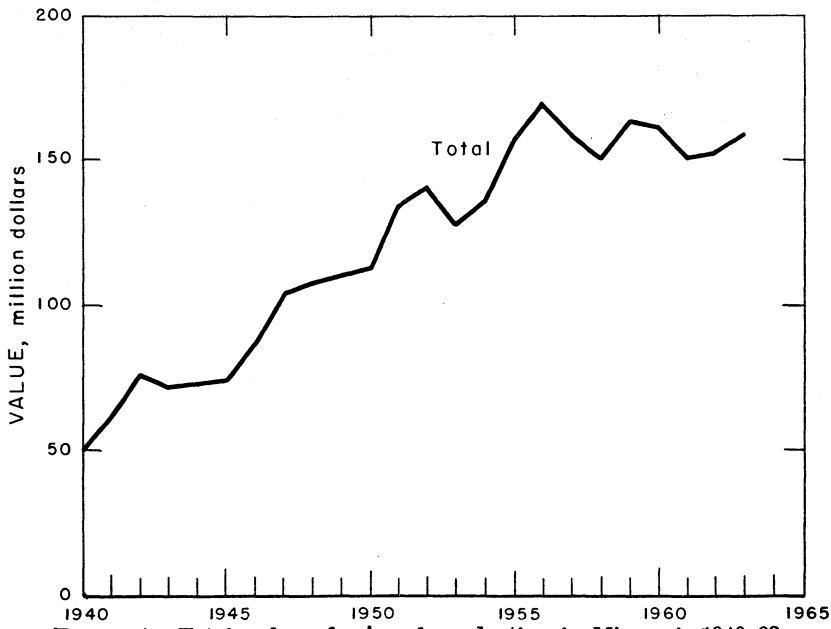


FIGURE 1.—Total value of mineral production in Missouri, 1940–63.

[1] Mining engineer, Bureau of Mines, Bartlesville, Okla.
[2] Assistant state geologist, Geological Survey and Water Resources, Rolla, Mo.

TABLE 1.—Mineral production in Missouri[1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	303,945	$3,994	286,750	$3,680
Cement:				
Portland—thousand 376-pound barrels	12,739	44,004	12,402	41,640
Masonry—thousand 280-pound barrels	455	1,457	417	1,345
Clays—thousand short tons	2,053	5,033	1,746	4,467
Coal (bituminous)—do	2,896	12,057	3,174	13,196
Copper (recoverable content of ores, etc.)—short tons	2,752	1,695	1,816	1,119
Iron ore (usable)—thousand long tons, gross weight	346	3,188	345	3,085
Lead (recoverable content of ores, etc.)—short tons	60,982	11,221	79,844	17,246
Lime—thousand short tons	1,176	13,703	1,240	14,386
Natural gas—million cubic feet	92	23	100	27
Petroleum (crude)—thousand 42-gallon barrels	55	(2)	[3] 54	(2)
Sand and gravel—thousand short tons	10,304	11,572	10,653	12,260
Silver (recoverable content of ores, etc.) thousand troy ounces	491	533	132	168
Stone—thousand short tons	28,876	44,006	30,885	46,130
Zinc (recoverable content of ores, etc.)—short tons	2,792	642	321	74
Value of items that cannot be disclosed: Native asphalt, gem stones, and values indicated by footnote 2		179		168
Total		153,307		158,991

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Included with "Value of items that cannot be disclosed."
[3] Preliminary figure.

change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$152,801	1958	$153,991
1953	135,159	1959	158,976
1954	141,746	1960	159,148
1955	154,295	1961	151,211
1956	157,121	1962	153,894
1957	158,710	1963	159,075

Trends and New Developments.—A number of important developments occurred in 1963 that were significant to the mineral industry.

St. Joseph Lead Co. was developing a new lead mine and processing mill northeast of Bunker, Reynolds County, at an estimated cost of $11.5 million. Capacity of the mine was expected to be 5,000 tons of high-grade lead ore per day, an increase of 25 percent in the company's Missouri production. Construction began in June 1963.

Bethlehem Steel Co. announced expenditures of $250 million on an integrated steel complex that will be situated on Lake Michigan. Iron ore pellets are expected to come from its Pea Ridge mine in Missouri.

Granite City Steel Co. increased productivity of one of its two blast furnaces from 1,450 tons to 1,800 tons per day by enlarging diameter of the furnace hearth. When operating at capacity, Granite City uses

1.5 million tons of iron ore; 15 to 25 percent of the ore is supplied under a 10-year contract by The Hanna Mining Co., Missouri Division, Iron Mountain mine. In 1963, nearly 250,000 tons of usable ore, or 70 percent of Missouri's shipments, was purchased.

St. Joseph Lead Co. announced that smelting capacity will be doubled when new facilities are completed at its Herculaneum lead smelter. The $10 million expansion and modernization program will include an updraft sintering process, larger blast furnaces, provide facilities for an appreciable tonnage of sulfuric acid, increase refining capacity, and automate materials handling equipment.

A feasibility study of basic oxygen furnace technology was being made for Granite City Steel Co. by Koppers Co., Inc.

Exploration.—Large-scale mineral exploration continued in the southeast Missouri mining district during 1963; 16 major mining companies were actively engaged in prospecting for lead and iron ores. According to the Clark National Forest Annual Review, at yearend there were 72 mineral prospecting permits covering 80,117 acres and 18 mineral leases covering 14,884 acres. During the year, six prospecting permits were converted to leases, reflecting discovery of ore in sufficient quantities to merit development or further investigation as to quality and quantity.

American Zinc, Lead and Smelting Co. reported that its joint exploration venture with Granite City Steel Co. in the Boss-Bixby area resulted in discovery of 200 million tons of magnetite-bearing iron ore. Twenty-six holes were drilled into the ore body. Feasibility reports from consultants indicated that the ore body could furnish ore to make 1.5 million tons of iron pellets annually, averaging more than 65 percent iron.

Government Programs.—Mineral receipts from royalties, prospecting permits, and mineral leases on Federal land within the State totaled more than $125,000.

Federal, State, county, and municipal funds financed many construction projects throughout the State. These projects, especially road building and maintenance, consumed a large part of the output of construction material such as cement, clays, lime, sand and gravel, and stone. Contracts awarded for road work in the State during the year totaled nearly $175.7 million.[3] Of this amount, 82.5 percent went for construction, 15.4 percent went for right-of-way acquisition, and the remaining 2.1 percent was spent for road oiling programs. The work covered 2,623.1 miles of Missouri's roads and highways.

Missouri's largest industrial municipal bond issue amounting to $5 million was approved by the Missouri Division of Commerce and, subsequently, by the voters of Annapolis, Mo. Money derived from sale of the bonds was used to finance construction of a roofing granules plant which will be leased to Ruberoid Co. Ruberoid will process locally produced raw materials into high-quality, ceramic-coated roofing granules.

Resources work in the State by the Federal Bureau of Mines included a copper, lead-zinc survey and a mineral industry survey of Missouri. The latter will include a study of all mineral resources of

[3] Missouri Limestone News. V. 19, No. 2, February 1964.

the State in order to determine reserves, uses, and their economic status.

At the Rolla Metallurgy Research Center, Rolla, research was directed toward improving recovery of various minerals from complex ores and better understanding of physical properties of metals. Current projects by Bureau of Mines engineers include: Behavior of reagents during flotation processing; beneficiation of subgrade refractory clays; hydrogen reduction of sulfide minerals; and germanium and gallium from fly ash.

Grants of $56,000 were awarded by the National Science Foundation to the Department of Earth Sciences of Washington University to support research in the field of rock magnetism and paleo magnetics.

Area Redevelopment Administration announced that $22.9 million had been invested in Missouri under the area redevelopment and accelerated public works program. Expenditures included $2.5 million in Federal funds contributed under the area redevelopment program, $10.9 million under the public works program, $0.7 million contributed by other Federal agencies under the public works program, and, $8.8 million by local and private investments.

The Missouri Division of Commerce and Industrial Development engaged Arthur D. Little, Inc., Cambridge, Mass., to study the economic potential of specific types of manufacturing in Missouri. As a part of this program, the firm was making a market study of the feasibility of an integrated steel industry in Missouri, utilizing known iron ore resources and other raw materials.

In September, the Federal Geological Survey announced that topographic map coverage of Missouri's land surface was 95 percent complete. Three hundred and fifty-six additional 15-minute quadrangles were needed for complete coverage.

Employment and Injuries.—At yearend, there were 1,753,100 workers employed in Missouri's industries compared with 1,760,000 in 1962, a decrease of 6,900 workers. However, despite a decline in overall State employment, mining industry employment rose 1 percent to 6,888 workers. The increase was due to a high level of mining activity in southeast Missouri including opening of a new iron mine in Washington County.

Labor disputes plagued the mining industry during the year. The strike closing St. Joseph's mines in southeast Missouri in July 1962 was not settled until April 1963. A total of 247 working days was lost at an estimated cost of $3.5 million in wages and labor and $2 million to the lead industry.

A 19-day steamfitters strike in August delayed surface construction work at the Pea Ridge mine, Meramec Mining Co. The jurisdictional dispute idled 445 construction workers employed by 13 contractors. However, iron ore miners, members of the United Steel Workers, continued underground development work during the strike.

In April, General Chemical Division, Allied Chemical Corp., announced that the Owenville plant had operated 5,089 consecutive working days without a lost-time injury.

Under legislation approved by the President in May 1963, the rate of Federal unemployment tax was reduced from 3.5 percent to 3.35

TABLE 3.—Average annual employment of mining industries

Industry	1959	1960	1961	1962	1963
Metal mining	3,263	3,195	2,700	[1] 1,821	2,151
Nonmetal mining	4,286	3,820	3,950	[1] 4,205	4,003
Coal mining	856	864	777	796	734
Total	8,405	7,879	7,427	[1] 6,822	6,888

[1] Revised figure.

Source: Division of Employment Security, Department of Labor and Industrial Relations, State of Missouri.

percent. The reduced rate was applied to wages paid on or after January 1, 1963.

The Missouri Limestone Producers Association (MLPA) presented Safety Commendation Awards to 15 limestone quarry operators who had no lost-time accidents during the past year. The competition is jointly sponsored by the MLPA and the Federal Bureau of Mines as an incentive to control work injuries in the mineral industries.

Water.—Water problems including long-range supply, quality, pollution, re-use, and treatment received increasing attention during 1963 from Federal and State agencies, planning organizations, and private research institutions. During 1963, the Bureau of Mines canvassed the mineral producers for water usage in 1962. The data will be utilized in a nationwide study of water resources. Mineral industries use water for cooling, processing, sanitary, and service purposes.

The Missouri Water Pollution Board issued regulations for prevention of pollution of ground water in the State. Permits are required for disposal of sewage, industrial, or other waste products into ground water reservoirs.

TABLE 4.—Water use in the mineral industry in 1962

(Million gallons)

	New water	Water re-circulated	Total water use	Water discharged	Water consumed
Quarries and mills	260	78	338	80	180
Coal (bituminous)	225	1,068	1,293	116	109
Metal mines and mills	3,161	1,616	4,777	3,033	128
Nonmetal mines and mills	3,327	4,729	8,056	3,170	157
Sand and gravel mines	8,803	2,675	11,478	8,610	193
Petroleum	1		1		1
Total	15,777	10,166	25,943	15,009	768

Schumer Spring, Perry County, was designated as an "Ebb and Flow Spring" by the Missouri Geological Survey and Federal Geological Survey. Cooperative studies showed that peak flow of the spring occurs at 3-hour intervals. There are now 7 known ebb and flow springs in Missouri, a total of 25 in the continental United States.

Three years after construction began, Union Electric Co. completed its Taum Sauk power plant project. The facility uses hydroelectric equipment to generate electricity and to store water, thus making it

less dependent on upstream rainfall. Taum Sauk utilizes surplus off-peak, steam-generated electricity to pump water into a manmade lake covering 54.6 acres, situated 800 feet above the powerhouse; subsequently, the stored water is routed back through the turbines to generate electricity for meeting daytime peak demands.

Economic Indicators.—According to the U.S. Department of Commerce, personal income in Missouri rose 5 percent to $10.9 million in 1963. Every major industry showed substantial increases in income except farming; the sharpest increase was made by the construction industry. Per capita income was reported at $2,508 compared with the national average of $2,401.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Output of nonmetals was about equal to that of 1962. Increased production of lime, sand and gravel, and stone was offset by decreases in barite, cement, and clays. The more important nonmetals, in order of value, were stone, cement, lime, and sand and gravel.

Barite.—Shipments of barite decreased 6 percent in quantity and 8 percent in value. Output was reported in two counties; Washington County furnished nearly all the State's production. At yearend, barite held in stock by producers totaled 25,372 tons, about 30 percent less than in 1962.

Despite the decline in 1963, Missouri ranked first in the Nation in quantity and value of barite shipments. Active mining companies totaled 12; Magnet Cove Barium Corp., Milwhite Mud Sales Co., and National Lead Co., the State's leading producers, accounted for about one-half of the production.

Crushing and grinding plants in St. Louis and Washington Counties processed two-thirds of the shipments; the rest was processed in Arkansas and Texas. Principal uses, in order of importance, were drilling mud, glass, rubber, and paints.

TABLE 5.—Barite sold or used by producers

Year	Short tons	Value	Year	Short tons	Value
1954–58 (average)	314,949	$3,623,643	1961	227,323	$3,051,663
1959	396,093	3,923,651	1962	303,945	3,994,104
1960	180,702	2,587,820	1963	286,750	3,679,764

Cement.—Portland cement was produced at two plants in St. Louis County and one each in Cape Girardeau, Jackson, and Ralls Counties. Shipments decreased both in quantity and value as compared with those of 1962. Value declined by a greater percentage than tonnage because of a 9-cent-per-barrel drop in average price. At yearend, about 1.5 million barrels of portland cement was in stock, 9 percent more than in 1962. The wet process was used in about 60 percent of portland cement production; the remainder was manufactured by the dry process.

TABLE 6.—Portland cement production and shipments

(Thousand 376-pound barrels and thousand dollars)

Year	Production	Shipments		Year	Production	Shipments	
		Quantity	Value			Quantity	Value
1954–58 (average)	11,731	11,651	$35,382	1961	11,940	11,839	$41,142
1959	13,610	13,583	45,430	1962	12,239	12,739	44,004
1960	12,606	11,856	40,915	1963	12,692	12,402	41,640

Shipments of masonry cement were about 8 percent below that of 1962. Average price per barrel was $3.22 compared with $3.20 last year. Five plants prepared masonry cement by mixing portland cement, finely ground limestone, and a plasticizer additive. Yearend stocks of masonry cement totaled more than 500,000 barrels, an increase of 20 percent.

Missouri cement plants operated at 80 percent capacity. The industry reported consumption of 280.7 million kw.-hr. of electrical energy; 85 percent of the power was purchased and 15 percent was captive.

Intensified competition characterized Missouri's cement industry in 1963. Production of both portland and masonry cement exceeded demand and resulted in a weakening of the general price structure and an increase in marketing costs. Service became an important factor and cement producers were forced to maintain bulk storage and distribution facilities in major cities in order to hold customers.

Universal Atlas Cement was making a detailed design and engineering study which would result in modernizing and enlarging cement producing facilities at its Hannibal plant.

Mississippi River Fuel Corp. began constructing a 6-million-barrel-capacity cement plant costing $25 million near Selma.

Truck transportation of bulk cement using entrained systems has been introduced, thus extending the marketing radius.

TABLE 7.—Shipments of portland cement to Missouri consumers

Year	Missouri (thousand 376-pound barrels)	Change, percent		Year	Missouri (thousand 376-pound barrels)	Change, percent	
		In Missouri	In United States			In Missouri	In United States
1954–58 (average)	7,524	----------	----------	1961	8,066	+5	+3
1959	8,825	+16	+9	1962	8,814	+9	+3
1960	7,684	−13	−7	1963	8,990	+2	+5

Clays.—Reported shipments of refractory clays declined in quantity for the fifth consecutive year.

Decreases in Missouri fire clay production were due in part to lower market requirements and a diminishing supply of quality clays. Fire clay technology has improved the quality and life of clay products, thereby requiring a lower unit production. High-grade clay deposits are in short supply and cost of mining a ton of clay is approaching its economic limit.

TABLE 8.—Clays sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Fire clay [1]		Miscellaneous clay		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	1,484	$5,909	855	$973	2,339	$6,882
1959	1,657	5,920	978	978	2,635	6,898
1960	[2] 1,541	6,208	999	999	2,540	7,207
1961	[2] 1,112	4,020	1,020	1,020	2,132	5,040
1962	1,080	4,060	973	973	2,053	5,033
1963	850	3,568	896	899	1,746	4,467

[1] Includes diaspore and burley clay.
[2] Includes ball clay.

Fire clay was mined in 14 counties and comprised less than half of the tonnage but about 80 percent of the value of clays sold or used in Missouri. Important uses of fire clays were fire clay brick and shapes, high alumina brick and shapes, chemicals, and mortar.

Miscellaneous shale or clay was produced in 10 counties. Output decreased 8 percent in quantity and value compared with 1962. Important uses of shale were building brick, cement, sewer pipe, pottery, and other heavy clay products.

During 1963, improved and new products in substantial number were introduced by the refractories industry. Missouri clays were used to produce high heat-duty insulating specialty products for service at temperatures exceeding 2,800° F. A major company reported developing a refractory brick for surfacing missile launching pads.

Major expansion or modernization projects were completed by the clay industry. Midland Brick & Tile Co., Utica, installed a continuous kiln; Walsh Refractories Corp., Vandalia, increased capacity of its batching plant; and Wellsville Fire Brick Co., Wellsville, increased floor space by 40,000 square feet. Acme Brick Co., Ft. Worth, Tex., purchased the plant of Martin-Marietta's United Brick Division in Kansas City, Mo.

Lime.—Output of lime increased 5 percent in quantity and value. Most of the lime was sold for various industrial uses; 4,119 tons was used by a Missouri producer. Average value of a ton of lime was $11.60 compared with $11.65 in 1962.

Principal markets for Missouri lime were chemical and industrial plants which purchased 80 percent of the output; steel and construction industries utilized 13 percent and 7 percent, respectively.

Five plants situated in four Missouri counties manufactured lime products. Of the five plants, four produced hydrated lime and quicklime, and one plant produced dead burned lime. The Ash Grove Lime & Portland Cement Co. plant in Greene County was closed and dismantled.

Sand and Gravel.—Output of sand and gravel was the highest on record, increasing 3 percent in quantity and 6 percent in value over that of 1962. Specifications for higher quality sand for use in concrete aggregate mixtures resulted in a higher unit cost.

Over 9.8 million tons of sand and gravel was mined at 79 commercial operations. Three of these produced over 500,000 tons each for a

TABLE 9.—Lime sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quicklime	Hydrated lime	Total lime	
			Quantity	Value
1954–58 (average)	1,108	220	1,328	$14,400
1959	1,089	235	1,324	15,714
1960	1,030	224	1,254	14,701
1961	958	215	1,173	13,873
1962	(1)	(1)	1,176	13,703
1963	(1)	(1)	1,240	14,386

[1] Figure withheld to avoid disclosing individual company data; included with "Total lime."

total of 2.2 million tons; 28 preparation plants were in the 100,000 to 500,000 range and supplied 6.1 million tons; and 48 operations produced up to 100,000 tons each for a total of 1.5 million tons.

Total sand and gravel, including Government-and-contractor, was transported, 75 percent by truck, 16 percent by railroad, and the remainder by waterway and other methods.

Sand constituted 6.1 million tons valued at $8 million of the total sand and gravel output and was utilized for construction and industrial purposes. Construction sand was principally used for building, paving, fill, and railroad ballast. Industrial sand was produced for glass, grinding and polishing, blast sand, molding, filtration, and engine sand.

Gravel production, used for building and paving purposes, totaled 4.5 million tons valued at $4.3 million.

Stone.—Stone ranked first in value of mineral commodities produced in Missouri. Output gained 7 percent in quantity and 5 percent in value. Limestone, granite, marble, sandstone, and miscellaneous stone were mined in 82 counties. Continued high level of activity in all phases of construction accounted for increased stone production.

Limestone for construction, cement, and lime manufacture represented about 96 percent of stone output in Missouri. Demands were higher in construction and in the lime manufacture category; cement requirements were down as compared with 1962.

Crushed and dimension granite was produced in Iron County. Uses of granite in order of value were building and monumental.

TABLE 10.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	8,163	$8,900	1,219	$894	9,382	$9,794
1959	9,573	10,959	706	447	10,279	11,406
1960	9,631	11,194	576	407	10,207	11,601
1961	8,744	10,266	627	422	9,371	10,688
1962	9,445	10,927	859	645	10,304	11,572
1963	9,808	11,580	845	680	10,653	12,260

TABLE 11.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	3,307	$2,909	3,658	$3,334
Paving	1,143	943	902	915
Fill	321	290	397	341
Industrial glass	419	1,064	450	1,164
Other [1]	546	2,008	638	2,149
Total	5,736	7,214	6,045	7,903
Gravel:				
Building	1,908	2,203	2,156	2,307
Paving	1,702	1,440	1,452	1,247
Fill	16	11	8	6
Other [2]	83	59	147	117
Total	3,709	3,713	3,763	3,677
Total sand and gravel	9,445	10,927	9,808	11,580
Government-and-contractor operations:				
Sand:				
Paving	57	57	85	103
Gravel:				
Building			42	30
Paving	802	588	718	547
Total sand and gravel	859	645	845	680
Grand total	10,304	11,572	10,653	12,260

[1] Includes molding, filtering, railroad ballast, and other construction, industrial, and ground sand.
[2] Includes railroad ballast and miscellaneous gravel.

TABLE 12.—Sand and gravel production in 1963, by counties

County	Short tons	Value	County	Short tons	Value
Benton	4,590	$3,910	Maries	48,071	$48,457
Buchanan	218,226	227,455	Moniteau	10,986	10,037
Butler	25,274	20,557	Monroe	14,731	10,913
Callaway	48,200	40,350	Montgomery	86,920	73,549
Carroll	3,295	4,119	Morgan	41,391	34,403
Carter	8,100	6,600	Ozark	3,820	2,978
Cedar	16,178	11,395	Phelps	12,981	12,052
Chariton	725	906	Pike	18,486	14,500
Christian	19	13	Polk	17,268	10,866
Cole	222,147	196,514	Pulaski	79,487	93,453
Crawford	35,148	29,387	Reynolds	9,455	7,104
Dade	7,225	5,084	St. Clair	4,050	2,850
Daviess	29,862	44,240	St. Francois	60,560	69,679
Douglas	330,750	218,750	St. Louis	4,757,145	5,659,828
Franklin	366,066	399,240	Stone	15,368	12,522
Gasconade	17,282	19,124	Sullivan	8,925	10,264
Jefferson	471,237	977,980	Texas	24,520	28,198
Laclede	50,701	37,714	Vernon	4,893	1,850
Lafayette	136,000	126,000	Wright	13,527	9,519
Lawrence	15,595	11,577	Other counties [1]	3,342,278	3,708,689
Livingston	29,935	28,315			
McDonald	41,136	28,923	Total	10,652,553	12,259,264

[1] Includes Barry, Bates, Boone, Camden, Cape Girardeau, Cooper, Dunklin, Gentry, Howard, Howell, Jackson, Jasper, Lewis, Lincoln, Miller, Nodaway, Osage, Pemiscot, Perry, Ralls, St. Charles, Ste. Genevieve, Stoddard, Taney, Warren, Washington, Wayne, and Webster Counties, combined to avoid disclosing individual company confidential data. Undistributed amounts from various counties are also included.

TABLE 13.—Stone sold or used by producers, by kinds

Year	Granite		Marble		Limestone	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1959	3,111	$276	181,070	$1,704	25,980,397	$33,944
1960	3,806	233	148,930	1,737	26,410,534	35,475
1961	4,532	295	139,477	2,125	24,852,463	33,716
1962	4,452	286	(1)	(1)	27,900,975	40,889
1963	2,958	317	(1)	(1)	29,756,401	42,652

Year	Sandstone		Miscellaneous stone [2]		Total stone	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1959	5,209	$83	769,553	$428	26,939,340	$36,435
1960	2,811	42	614,287	391	27,180,368	37,878
1961	2,948	42	631,250	399	25,630,670	36,577
1962	[3] 2,943	38	495,226	345	28,876,422	44,006
1963	[3] 3,655	55	576,111	484	30,884,541	46,130

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Total stone."
[2] Chat; also includes small quantity of other stone.
[3] Excludes crushed sandstone; included with "Total stone."

TABLE 14.—Stone production in 1963 by counties

County	Short tons	Value	County	Short tons	Value
Boone	685,502	$872,714	McDonald	369	$443
Buchanan	173,316	259,364	Moniteau	46,150	78,330
Caldwell	115,929	192,183	Monroe	100,683	139,411
Callaway	377,129	539,281	Morgan	5,500	6,600
Carter	3,464	3,637	Newton	54,576	86,100
Cedar	48,225	72,553	Phelps	30,000	50,000
Clay	1,048,648	1,356,095	Pike	230,442	363,553
Clinton	108,671	169,715	Putnam	43,034	67,010
Cole	10,240	11,776	Reynolds	1,670	1,753
Dade	80,700	129,140	St. Charles	649,055	890,352
Daviess	202,600	327,000	St. Clair	98,127	129,009
Franklin	189,770	237,098	St. Francois	1,003,841	883,278
Grundy	206,362	284,839	St. Louis	5,483,235	6,605,385
Jackson	3,590,468	4,796,513	Saline	973,830	1,100,295
Jefferson	198,569	380,329	Vernon	145,097	219,144
Johnson	195,794	279,190	Wayne	50,000	62,500
Lawrence	122,211	148,800	Wright	20,000	38,366
Linn	106,295	205,184	Other Counties [1]	14,232,891	24,757,758
Livingston	187,148	300,052			
Maries	65,000	85,000	Total	30,884,541	46,129,750

[1] Includes Adair, Audrain, Barry, Barton, Bates, Cape Girardeau, Camden, Cass, Clark, Cooper, DeKalb, Gentry, Greene, Harrison, Henry, Holt, Howard, Iron, Jasper, Knox, Lafayette, Lewis, Lincoln, Madison, Marion, Mercer, Miller, Montgomery, Nodaway, Oregon, Perry, Pettis, Platte, Ralls, Randolph, Ray, Ste. Genevieve, Scotland, Scott, Shannon, Shelby, Taney, Warren, Webster, and Worth Counties, combined to avoid disclosing individual company confidential data. Undistributed amounts from various counties are also included.

Marble was produced in five counties; two reported crushed marble, two dimension marble, and one reported both crushed and dimension marble. Principle uses of marble were for building and terrazzo. Output was valued 5 percent higher than in 1962.

Miscellaneous stone, principally waste products of lead-zinc mining, was produced in Jasper and St. Francois Counties by five producers. Output was greater than in 1962 and was utilized for road base, railroad ballast, roofing granules, and fluxing.

TABLE 15.—Stone sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value	Quantity	Value
Dimension and building:				
Rough construction—short tons	13,802	$382,536	13,765	$302,206
Flagging and rubble—do	17,467	48,081	12,750	48,804
Rough architectural—cubic feet	5,962	22,891	(1)	(1)
Dressed (cut or sawed)—short tons	11,261	1,736,352	(1)	(1)
Total—approximate short tons	43,029	2,189,860	38,412	2,263,828
Crushed and broken:				
Riprap—short tons	2,053,321	2,007,811	3,557,218	3,109,493
Concrete aggregate, roadstone, etc—do	17,134,330	23,320,627	17,496,786	23,570,633
Railroad ballast—do	139,127	71,689	261,193	146,314
Agricultural—do	2,852,619	4,616,789	2,684,423	4,601,017
Cement—do	3,381,010	3,381,010	3,313,242	3,313,242
Other [2]—do	3,272,986	8,418,452	3,533,267	9,125,223
Total—do	28,833,393	41,816,378	30,846,129	43,865,922
Grand total—do	28,876,422	44,006,238	30,884,541	46,129,750

[1] Figure withheld to avoid disclosing individual company confidential data; included in totals.
[2] Includes stone for terrazzo, roofing granules, glass, whiting, asphalt filler, fertilizer filler, other filler, coal dust, filter beds, mineral food, poultry grit, stone sand, lime, refractory, flux, and miscellaneous.

Crushed sandstone was mined for riprap in Platte and Saline Counties; dimension sandstone was prepared for building stone in Camden, Shannon, and Vernon Counties. Output was greater than in 1962.

Commercially produced crushed stone was transported by truck (82 percent), water (8 percent), and rail and other methods (10 percent).

METALS

Output of five metals was valued at $21.7 million compared with $17.3 million in 1962 and represented 14 percent of total mineral production value in Missouri. Lead was the principal metal produced and offset declines reported for copper, iron, silver, and zinc.

Copper, Zinc, and Silver.—Copper, zinc, and silver, associated with lead ores in southeast Missouri's "lead belt", were recovered as a byproduct of milling, smelting, and refining operations. Output was dependent on the volume of lead ores mined, percent of concentration and mineral economics. Despite a 9-percent increase in crude ore mined, reported production of copper and zinc decreased appreciably. The supply of silver-bearing residue was less than last year and resulted in a lower output.

No zinc was produced in the southwestern Missouri part of the Tri-State district for the 6th consecutive year.

Iron Ore.—Almost 1 million tons of hematite and limonite iron-bearing ores were mined by open pit and underground method in Howell, St. Francois, and Wayne Counties. Underground mining accounted for about two-thirds of the production. The ores were concentrated in company-operated plants and shipped to cement, chemical, and steel industries outside of the State. Iron content of the concentrate averaged 52.96 percent.

Shipments of usable iron ore approximated that of last year. Year-end stock of usable iron ore was 43,727 tons compared with 20,283 tons in 1962.

TABLE 16.—Iron ore (usable)

Year	Long tons	Value	Year	Long tons	Value
1954–58 (average)	343	$3,216	1961	341	3,633
1959	349	3,278	1962	346	3,188
1960	365	3,760	1963	345	3,085

Meramec Mining Co. developed the Pea Ridge property. Underground progress during the year consisted of 9,475 feet of crosscutting, 14,927 feet of drifting, and 3,733 feet of raising. A 10-inch, 4-mile-long pipeline was laid from the surface plant to the Meramec River. At yearend, construction of the pelletizing plant was approaching completion, and the first carload shipment of iron ore pellets was expected early in 1964.

TABLE 17.—Ferrous scrap and pig iron consumption

(Short tons)

Year	Ferrous scrap	Pig iron	Total scrap and pig iron
1959	843,155	73,518	916,673
1960	827,811	44,649	872,460
1961	869,002	24,246	893,248
1962	864,994	29,247	894,241
1963	908,272	33,490	941,762

Lead.—Output of recoverable lead was considerably higher than in 1962 when production was disrupted because of labor problems. The metal was recovered from 3.25 million tons of lead ores produced at four mines in Crawford, Iron, St. Francois, and Washington Counties.

TABLE 18.—Mine production of silver, copper, lead, and zinc, in terms of recoverable metals

Year	Mines producing	Material sold or treated		Silver		Copper	
		Crude ore (short tons)	Old tailing (short tons)	Troy ounces	Value (thousands)	Short tons	Value (thousands)
1954–58 (average)		6,629,907	1,220,074	270,209	$245	1,714	$1,149
1959	4	5,573,517		339,760	308	1,065	654
1960	5	5,897,813		15,594	14	1,087	698
1961	7	5,242,779		11,793	11	1,479	887
1962	6	2,991,463		490,896	533	2,752	1,695
1963	4	3,253,245		131,664	168	1,816	1,119

Year	Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	122,782	$34,633	3,476	$837	$36,864
1959	105,165	24,188	92	21	25,171
1960	111,948	26,196	2,821	728	27,636
1961	98,785	20,350	5,847	1,345	22,593
1962	60,982	11,221	2,792	642	14,091
1963	79,844	17,246	321	74	18,607

TABLE 19.—Mine production of lead and zinc in southeastern and central Missouri, in terms of concentrates and recoverable metals[1]

Year	Lead concentrates (galena)		Zinc concentrates (sphalerite)		Recoverable metal content[2]			
					Lead		Zinc	
	Short tons	Value[3] (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1954–58 (average)	174,913	$29,979	5,347	$442	122,674	$34,600	2,735	$662
1959	146,765	21,698	206	12	105,165	24,188	92	21
1960	155,781	23,105	5,602	446	111,948	26,196	2,821	728
1961	137,862	18,720	11,024	973	98,785	20,350	5,847	1,345
1962	83,897	10,620	5,135	492	60,982	11,221	2,792	642
1963	109,960	15,054	666	50	79,844	17,246	321	74

[1] Based on southeastern and central Missouri ore "dirt" and old tailing treated at mills.
[2] In calculating metal content of ores from assays, allowance has been made for smelting losses. In comparing values of concentrate "ore" and metal, value for concentrate is that received by producer, whereas value of lead and zinc is calculated from average price for all grades.
[3] Values are arbitrary, because part of lead concentrate is smelted by producer.

TABLE 20.—Tenor of lead and zinc ore milled and concentrates produced in southeastern Missouri

	Southeastern Missouri	
	1962	1963
Concentrate production:		
Lead, short tons	83,897	109,960
Zinc, do	5,135	666
Concentrate obtained from:		
Lead, percent	2.80	3.38
Zinc, do	0.17	0.02
Metal content of ore:[1]		
Lead, do	2.04	2.45
Zinc, do	0.09	0.01
Average lead content of galena concentrate, do	74.17	74.09
Average zinc content of sphalerite concentrate, do	60.43	53.60
Average value per ton:		
Galena concentrate	$126.58	$136.91
Sphalerite concentrate	$95.82	$75.08
Total material milled, short tons	2,991,463	3,253,245

[1] Figures represent metal content of crude ore only as recovered in the concentrate; data on tailing losses not available.

TABLE 21.—Mine production of silver, copper, lead, and zinc in 1963 by months, in terms of recoverable metals

Month	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
January				
February				
March				
April		106	5,984	50
May	10,000	232	9,211	
June	25,523	219	8,044	55
July	25,608	238	9,824	53
August	25,440	233	10,126	
September	25,552	199	8,940	24
October	19,541	214	10,202	33
November		216	8,403	71
December		159	9,110	35
Total:				
1963	131,664	1,816	79,844	321
1962	490,896	2,752	60,982	2,792

Missouri again ranked first among the States in lead output for 1963, regaining the position held for 54 consecutive years prior to 1962. The labor dispute which closed the lead mines in 1962 was not settled until April 1963 and significantly affected the supply of metal.

Brisk demands for lead from battery makers and other users lowered stocks, thereby precipitating a series of nine price increases during 1963. At yearend, the price of lead had risen to 12.5 cents.

Sinking of Viburnum No. 29 production shaft in south Washington County continued during 1963; hoisting ore on a production basis is scheduled in 1964. St. Joseph Lead Co. started developing new lead reserves in Reynolds County. A total of $11.5 million will be invested in sinking 2 shafts and building a 5,000-ton-per-day mill and other surface plants. Completion of the project is expected in 1965 and will increase the company's Missouri production by 25 percent.

Other Metals.—No columbium, tantalum, silicon, or uranium ore was produced but these minerals were processed in Missouri plants. Potassium, tantalum fluorides, metallurgical-grade silicon metal, and high-purity monocrystal silicon were produced from imported materials by the Mallinckrodt Chemical Works at its St. Louis plant. Monsanto Co., formerly Monsanto Chemical Co., produced ultrapure silicon metal for the electronics industry at its plant in St. Charles. United Nuclear Corp., subsidiary of Mallinckrodt Chemical Works, produced uranium oxide and enriched uranium at its St. Louis plant using ores from captive mines in New Mexico.

MINERAL FUELS

Three mineral fuels furnished 8 percent of the total mineral wealth produced in Missouri. Value of output was more than $1 million higher than in 1962. The most important mineral fuel produced was coal.

Coal (Bituminous).—Output of bituminous coal increased nearly 10 percent in quantity and value compared with 1962, because of increased power-generating use by electric utilities. Demand for Missouri coal for use as a fuel to generate electrical energy was expected to increase because of technologic advances in mining and power transmission.

Twenty-three coal mines produced more than 1,000 tons each; all except five were strip operations. Seven mines in Henry, Howard, Macon, Putnam, and Vernon Counties produced less than 1,000 tons each. According to the Department of Labor and Industrial Relations, State of Missouri, the coal industry employed 734 workers.

TABLE 22.—Coal (bituminous) production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954–58 (average)	2,919	$11,965	1961	2,938	$12,567
1959	2,748	11,937	1962	2,896	12,057
1960	2,890	12,450	1963	3,174	13,196

Strip mine production from 18 mines in 10 counties accounted for nearly 99 percent of Missouri's coal output. Overburden removed during 1963 was about 57 million cubic yards; about 20 cubic yards of waste was stripped for each ton of coal produced.

Six cleaning plants processed 2.14 million tons of coal, or 67 percent of the State's output. A small quantity of coal was oil treated.

Petroleum and Natural Gas.—Crude petroleum was produced from 115 oil wells; output approximated that of 1962. American Oil Co., a subsidiary of Standard Oil Company of Indiana, at midyear placed a crude oil distillation facility on stream at its Sugar Creek, Mo., refinery. The new unit, with a capacity of 65,000 barrels daily, replaced four older units.

Marketed production of natural gas was reported from Clinton County; output approximated that of 1962. Eight gas wells were active in the Turney field. Some natural gas was produced for local markets in Caldwell County. Two wells produced from the Polo sandstone in the Pleasanton group of Pennsylvanian age.

In 1963, nine holes were drilled, totaling 12,155 feet, in four counties in search for oil and gas—all were dusters. Other developments in locating oil and gas reserves in Missouri consisted of leasing large acreages of land in Bates, Cass, and Vernon Counties by major oil companies. Also, a renewed interest in the Forest City basin, northwestern Missouri, was expected to result in some exploratory drilling in 1964.

REVIEW BY COUNTIES

Mineral production was reported in 105 of the 114 counties, 1 more than in 1962. No mineral production was reported in Andrew, Bollinger, Dallas, Dent, Hickory, Mississippi, New Madrid, Ripley, and Schuyler Counties. Twenty-two counties reported mineral production valued at $1 million or over, one less than last year. The five principal mineral-producing counties, St. Louis, Ste. Genevieve, St. Francois, Cape Girardeau, and Jackson, accounted for more than 56 percent of the total value of mineral production in Missouri.

Stone was produced in 82 counties; value of output in 19 of the counties exceeded $500,000. Sand and gravel was produced in 69 counties. Clays were mined at 83 pits situated in 21 counties, compared with 66 pits in 20 counties for 1962.

Only those counties with significant mineral developments are discussed; see table 23 for additional details.

Adair.—Coal was produced at the underground mine of Billy Creek Coal Co., Inc., near Novinger. Limestone was quarried and crushed for aglime, concrete aggregate, and roadstone.

Atchison.—Petroleum was the only mineral commodity produced in the county. Output came from six oil wells in the Tarkio pool.

Audrain.—The county ranked first in fire clay production. Eight companies mined refractory clay at nine pits; Havener mine, operated by Kaiser Refractory & Chemical Co., was the county's largest producer. Limestone was quarried and crushed near Mexico for aglime, concrete aggregate, and road surfacing.

TABLE 23.—Value of mineral production in Missouri, by counties[1]

County	1962	1963	Minerals produced in 1963 in order of value
Adair	$258,174	(2)	Coal, stone.
Andrew	(2)		
Atchison	(2)	(2)	Petroleum.
Audrain	1,332,225	$1,044,000	Clays, stone.
Barry	(2)	210,371	Stone, sand and gravel.
Barton	(2)	(2)	Stone, asphaltic sandstone.
Bates	(2)	339,723	Stone, sand and gravel.
Benton	13,996	3,910	Sand and gravel.
Boone	1,541,409	3,294,579	Coal, stone, sand and gravel, clays.
Buchanan	354,156	486,819	Stone, sand and gravel.
Butler	13,882	20,846	Sand and gravel, clays.
Caldwell	219,297	192,183	Stone, natural gas.
Callaway	1,490,721	1,115,083	Stone, clays, coal, sand and gravel.
Camden	14,826	60,451	Sand and gravel, stone.
Cape Girardeau	13,722,234	13,334,975	Cement, stone, clays, sand and gravel.
Carroll		4,119	Sand and gravel.
Carter	2,400	10,237	Sand and gravel, stone.
Cass	274,646	312,759	Stone, clays, petroleum.
Cedar	35,836	83,948	Stone, sand and gravel.
Chariton		906	Sand and gravel.
Christian	7,070	13	Sand and gravel.
Clark	432,473	369,436	Stone, coal.
Clay	1,102,267	1,356,095	Stone.
Clinton	166,066	194,715	Stone, natural gas.
Cole	89,154	208,290	Sand and gravel, stone.
Cooper	430,253	607,996	Stone, sand and gravel.
Crawford	2,404,052	3,563,522	Lead, copper, silver, clays, sand and gravel, stone.
Dade	247,500	223,724	Stone, coal, sand and gravel.
Dallas	4,830		
Daviess	236,209	371,240	Stone, sand and gravel.
De Kalb	159,002	(2)	Stone.
Dent	6,246		
Douglas	165,108	218,750	Sand and gravel.
Dunklin	100,000	(2)	Do.
Franklin	964,228	724,668	Sand and gravel, stone, clays.
Gasconade	1,081,593	967,981	Clays, sand and gravel.
Gentry	(2)	(2)	Stone, sand and gravel.
Greene	(2)	3,413,331	Lime, stone.
Grundy	175,012	284,839	Stone.
Harrison	277,588	(2)	Do.
Henry	4,765,479	5,551,473	Coal, stone.
Holt	5,140	(2)	Stone.
Howard	391,563	86,685	Sand and gravel.
Howell	639,928	726,695	Iron ore, sand and gravel.
Iron	2,290,808	4,036,678	Lead, stone, copper, silver.
Jackson	10,877,699	11,572,320	Cement, stone, sand and gravel, clays, petroleum.
Jasper	2,501,332	2,629,503	Stone, sand and gravel.
Jefferson	1,303,507	1,358,309	Sand and gravel, stone.
Johnson	182,940	279,190	Stone.
Knox	(2)	(2)	Do.
Laclede	8,313	37,714	Sand and gravel.
Lafayette	514,250	660,224	Stone, sand and gravel, coal.
Lawrence	13,329	160,377	Stone, sand and gravel.
Lewis	(2)	(2)	Sand and gravel, stone.
Lincoln	218,087	313,249	Sand and gravel, stone, clays.
Linn	222,401	205,184	Stone.
Livingston	326,325	378,367	Stone, clays, sand and gravel.
Macon	(2)	(2)	Coal.
Madison	(2)	(2)	Stone.
Maries	109,613	133,457	Stone, sand and gravel.
Marion	(2)	(2)	Stone, lime.
McDonald	4,954	28,766	Sand and gravel, stone.
Mercer	(2)	(2)	Stone.
Miller	118,143	157,732	Sand and gravel, stone, barite.
Moniteau	74,788	88,367	Stone, sand and gravel.
Monroe	415,637	400,746	Clays, stone, sand and gravel.
Montgomery	796,806	736,728	Stone, clays, sand and gravel.
Morgan	25,367	41,003	Sand and gravel, stone.
Newton	293,039	86,100	Stone.
Nodaway	(2)	(2)	Stone, sand and gravel.
Oregon	31,141	(2)	Stone.
Osage	97,439	(2)	Clays, sand and gravel.
Ozark	12,861	2,978	Sand and gravel.
Pemiscot	356,157	(2)	Do.
Perry	258,491	(2)	Stone, sand and gravel.
Pettis	(2)	(2)	Stone.
Phelps	95,018	141,477	Clays, stone, sand and gravel.
Pike	400,746	378,053	Stone, sand and gravel.
Platte	(2)	(2)	Stone, clays, petroleum.
Polk	21,000	10,866	Sand and gravel.

See footnotes at end of table.

TABLE 23.—Value of mineral production in Missouri, by counties [1]—Continued

County	1962	1963	Minerals produced in 1963 in order of value
Pulaski	(2)	$93,453	Sand and gravel.
Putnam	$440,129	506,783	Coal, stone.
Ralls	6,988,688	6,875,527	Cement, stone, clays, sand and gravel.
Randolph	2,209,916	311,059	Stone, coal.
Ray	(2)	(2)	Stone.
Reynolds	11,600	8,857	Sand and gravel, stone.
St. Charles	1,501,183	1,536,516	Stone, sand and gravel, clays.
St. Clair	(2)	1,953,241	Coal, stone, sand and gravel.
St. Francois	12,758,364	14,627,199	Lead, iron ore, lime, stone, copper, sand and gravel, zinc, silver.
Ste. Genevieve	17,790,518	17,439,475	Lime, stone, sand and gravel.
St. Louis	33,455,815	32,214,723	Cement, stone, sand and gravel, clays, petroleum.
Saline	1,110,476	1,100,295	Stone.
Scotland	----------	(2)	Do.
Scott	3,575	(2)	Do.
Shannon	75,373	(2)	Stone, iron ore.
Shelby	240,858	(2)	Stone.
Stoddard	229,084	(2)	Sand and gravel.
Stone	3,750	12,522	Do.
Sullivan	127,629	10,264	Do.
Taney	64,786	(2)	Stone, sand and gravel.
Texas	161,922	28,198	Sand and gravel.
Vernon	372,922	313,085	Stone, coal, petroleum.
Warren	348,729	286,723	Clays, stone, sand and gravel.
Washington	5,966,051	5,678,588	Barite, lead, copper, zinc, silver, sand and gravel.
Wayne	163,849	143,311	Sand and gravel, stone, iron ore.
Webster	----------	23,335	Sand and gravel, stone.
Worth	(2)	(2)	Stone.
Wright	73,839	47,885	Stone, sand and gravel.
Undistributed	14,513,190	12,558,211	
Total	153,307,000	158,991,000	

[1] Counties not listed because no production was reported in 1962 or 1963: Bollinger, Hickory, Mississippi, New Madrid, Ripley, and Schuyler.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Barry.—Douthitt Lime Co. and W. J. Menefee Construction Co. mined and crushed limestone for aglime, concrete aggregate, and road surfacing. Gravel for paving was processed for Missouri State Highway Department.

Barton.—Limestone was quarried and crushed for aglime, concrete aggregate, and road surfacing by John J. Stark, contractor, near Lamar. Bar-Co Roc Asphalt Co. mined asphaltic sandstone near Iantha for road surfacing.

Bates.—Limestone was quarried and crushed for aglime, concrete aggregate, and roadstone by three companies at four locations. Alvis Rock Products, Inc., produced dimension limestone for rough construction. Clyde S. Miller produced paving gravel at the Ranch pit near Rich Hill.

Boone.—Boone County ranked 10th in value of crushed limestone produced and 3d in value of coal mined. The Mark Twain mine of Peabody Coal Co. near Hinton completed its first full year of operation; output exceeded anticipated production. Adrian Materials Co., Boone Quarries, Inc., Central Stone Co., and Garrett City Quarry Co. mined and crushed limestone for aglime, concrete aggregate, and road surfacing. Columbia Sand Co. processed sand for building, paving, and fill. Shale and fire clay were mined by Columbia Brick & Tile Co. and used to produce building bricks.

Buchanan.—Pioneer Sand Co. processed sand near St. Joseph for building, paving, railroad ballast, and fill. Crushed limestone was

produced for aglime, concrete aggregate, riprap, and road surfacing by Everett Quarries, Inc., George W. Kerford Quarry Co., and L. S. Stafford.

Butler.—Grobe & Son, George Golden, Smittle Gravel Co., Kittredge Sand & Gravel Co., and Missouri State Highway Department produced sand and gravel for building and paving. Shale for heavy clay products was mined by A. D. Willis & Son Industries. Monsanto Co. started operating its new fertilizer-blending plant near Neelyville; six workers were employed.

Caldwell.—Stone was the only reported mineral commodity produced in the county; value of output was lower than in 1962. Two quarries were active and produced crushed limestone for aglime, concrete aggregate, riprap, and roadstone. The quarry of Kingston Stone Co. was purchased by Clarkson Construction Co. of Kansas City. Some natural gas was produced from two wells in Polo gasfield and used locally.

Callaway.—The 25-percent decline in total mineral value was attributed to lower production of clays and stone. The county ranked third in value of clays output and sixth in value of coal produced. Harbison-Walker Refractories, H. K. Porter Co., Inc., Kaiser Refractories & Chemical Co., and Walsh Refractories processed fire clay into firebrick and block, high-alumina brick, mortar, and clay crucibles. Auxvasse Stone & Gravel Co., Mo-Con Inc. of Fulton, Sulgrove Mining & Quarry Co., and Trager Quarries, Inc., produced crushed limestone for aglime, concrete aggregate, riprap, roadstone, and railroad ballast. Coal was strip mined at the Hammett pit by Clayton-Crowson Mining Co. Callaway County Sand Co. processed sand for building and paving.

Camden.—Dimension sandstone was mined for building purposes near Camdenton by Robert M. Beavers; about seven workers were employed. Missouri State Highway Department contracted for paving gravel.

Cape Girardeau.—The county ranked fourth in total mineral value, second in cement, third in miscellaneous clay, and fifth in stone. Marquette Cement Manufacturing Co. produced portland and masonry cement, using limestone and clays from company-operated quarries near Cape Girardeau. Limestone was quarried and crushed for aglime, concrete aggregate, riprap, and roadstone by Farmers Limestone Co. and the Federal Materials Co., Inc. Kasten Clay Products, Inc., and Ceramo Co., Inc., mined miscellaneous clay for building brick and pottery. Dock facilities on the Mississippi River were constructed by Kasten Clay Products, Inc., in order to transport raw materials and finished products by barge to plant and markets; about 15 additional workers were employed. Cape Girardeau Sand Co. processed sand for building, paving, and fill sand.

Carroll.—Missouri State Highway Department contracted for paving sand, the first mineral production reported in the county since 1958.

Cass.—A 14-percent increase in total value of mineral production was due to higher output of stone. Deitz-Hill Development Co., Hackler & Limpus Quarry, and Marino & Hoover Construction Co., Inc., mined and crushed limestone for aglime, concrete aggregate, and road-surfacing material. Miscellaneous clay was processed into building

brick by Acme Brick Co. near Harrisonville. About 5,400 barrels of oil was produced from 28 wells in the Clarke-Miller and Lisle oil pools.

Cedar.—George M. Baker quarried and crushed limestone for aglime, concrete aggregate, and roadstone. Missouri State Highway Department contracted for paving gravel.

Chariton.—Missouri State Highway Department contracted for paving sand. No mineral production had been reported from the county since 1955.

Clark.—Baker Quarry Co. mined and crushed limestone for aglime, concrete aggregate, and roadstone. Hamlin Bros. Coal Co. strip-mined coal for local markets.

Clay.—The county ranked fourth in value of crushed limestone which was the only mineral produced. Value of output rose 23 percent because of high residential and industrial construction in the area. Four commercial and one Government-and-contractor operations quarried limestone for aglime, concrete aggregate, riprap, and roadstone.

Clinton.—Mineral output rose 17 percent due to increased stone production. Everett Quarries, Inc., mined and crushed limestone at three locations for aglime, concrete aggregate, riprap, and roadstone.

Cole.—Value of mineral production was significantly above that of 1962 because of increased output of sand and gravel. Jefferson City Sand Co. and C. W. Roweth Co. produced sand and gravel for building, paving, and fill. The county highway department produced paving gravel. Limestone was quarried and crushed for riprap by Brown Quarries, Inc.

Cooper.—Higher production of stone accounted for an increase of 41 percent in total mineral value. J. A. Tobin and U.S. Army Corps of Engineers mined and crushed limestone for concrete aggregate, riprap, and roadstone. Near Booneville, Missouri River Sand & Gravel Co. processed sand and gravel for paving and fill. Paving gravel was produced for Missouri State Highway Department.

Crawford.—Crawford County ranked 10th in value of mineral output and 3d in value of recovered lead. Over 400,000 tons of lead ore was mined at the St. Joseph Lead Co. No. 27 mine. The ore was transported in 30-ton trucks to the Viburnum mill in Iron County for processing. Fire clay was mined at two pits and processed into firebrick and block by the Refractory Division of H. K. Porter Co., Inc. Sand and gravel was produced for building, paving, and miscellaneous uses by G. J. Marr and Clyde Denton, Inc. Missouri State Highway Department contracted for paving gravel.

Dade.—Mineral commodities produced in Dade County were stone, coal, and sand and gravel. Crushed limestone was produced for aglime, concrete aggregate, and roadstone by Allen Quarries. Coal was strip-mined by Tyler & Claypool Coal Co. Paving gravel was produced for Missouri State Highway Department.

Daviess.—Value of mineral output rose more than 50 percent because of increased stone production; demand for stone was generated by an active highway building program in the area. Snyder Quarries, Inc., mined and crushed limestone at two locations for aglime, concrete aggregate, and roadstone. Bethany Falls Transit Mixed Concrete Co.

pumped sand from the Grand River near Pattonsburg for building, paving, and other construction purposes.

De Kalb.—Stone, the only mineral commodity produced in De Kalb County, increased in value over 1962. Highway construction in the area required large quantities of stone. Everett Quarries, Inc., quarried and crushed limestone for aglime, concrete aggregate, riprap, and roadstone.

Douglas.—Sand and gravel was the only mineral commodity produced in Douglas County; valued output rose more than 30 percent. Welton & Gray Gravel Co. and Valentine Supply Co. processed paving gravel near Ava.

Dunklin.—Sterling Aluminum Products Corp., leading producer of permanent mold aluminum castings and automotive pistons, constructed a new manufacturing plant near Malden. When operating at full capacity, a minimum of 150 workers will be employed. Wilkey & Lankford, Inc., produced sand and gravel for paving near Campbell.

Franklin.—Five commercial operators mined and crushed limestone at six locations for aglime, concrete aggregate, riprap, and roadstone; Oliver L. Taetz, Inc., was the largest producer. Clifford Dewert, Meramec Aggregates, Inc., Pacific Pebbles, Inc., and Washington Sand Co. produced sand and gravel for building and paving. Missouri State Highway Department contracted for paving gravel. Fire clay was mined at five pits and processed into firebrick and block, high-alumina brick, mortar, and clay crucibles by Kaiser Refractory & Chemical Division, Wellsville Fire Brick Co. and Walsh Refractories Corp.

Gasconade.—The county ranked second in value of fire clay output. Seven companies mined fire clay at 20 pits for use in manufacturing refractories; A. P. Green Fire Brick Co. and Kaiser Refractory & Chemical Co. were the largest producers. George J. Engeman processed building and paving gravel near Herman. Missouri State Highway Department contracted for paving sand.

Gentry.—Stone and sand and gravel were produced in Gentry County; output approximated that of 1962. Albany Gravel Co., Inc., quarried and crushed limestone for aglime, concrete aggregate, and roadstone, and also produced paving gravel. Farm-Lime Manufacturing Co. opened a plant near King City to produce livestock oilers, water tanks, and farm wagons.

Greene.—The county ranked 11th in total value of mineral production, 3d in lime output, and 5th in value of crushed limestone. Ash Grove Lime & Portland Cement Co. quarried limestone at two locations to manufacture hydrated lime and quicklime at its Springfield and Galloway plants. In April, the Springfield plant was closed and production activities centralized at the Galloway plant. Five commercial operations mined and crushed limestone for aglime, concrete aggregate, and roadstone. Sawed and cut marble was prepared for building purposes at the quarry operated by Carthage Marble Corp.

Grundy.—Stone, the only mineral commodity produced in Grundy County, increased more than 60 percent in value of output. Increased production of stone was generated by an active road building program in the area. Mullins Farm Supply Co., Trager Quarries, Inc., and

E. E. Trenary quarried and crushed limestone for aglime, concrete aggregate, riprap, and roadstone.

Harrison.—Davis-Snyder Quarries, Inc., L. W. Hayes, Inc., and E. I. Sargent mined and crushed limestone for aglime and road surfacing.

Henry.—Henry County ranked first in value of coal mined and eighth in the total mineral value. Five strip mines were active; two were operated by Peabody Coal Co. and one each by Bud Jones Coal Co., Hoppe Coal Co., and Madole Bros. Coal Co. Limestone was quarried and crushed for aglime, concrete aggregate, riprap, and roadstone by Williams Rock Co., Inc., Williams Rock Mining Co., Inc., Davis Rock Co., and O. A. Knisely Lime Co.

Holt.—The county ranked sixth in value of crushed limestone produced. Output of stone, the only mineral produced, rose significantly. Increased production was generated by an active highway building program. Gordon Bros. Quarries, Inc., quarried and crushed limestone for aglime, concrete aggregate, riprap, and roadstone.

Howard.—Glasgow Sand Co. mined sand for building purposes and the Missouri State Highway Department contracted for paving sand. Limestone was quarried and crushed for concrete aggregate, riprap, and roadstone by Glasgow Quarries, Inc.

Howell.—The county ranked second in value of usable iron ore shipments. Brown iron was mined by Shook & Fletcher Supply Co., Plateau Iron Ore Corp., and Schroeder Mining Co. of Missouri. Doss & Harper Gravel Co. processed paving gravel near West Plains. Kerr-McGee Oil Industries obtained an option on 360 acres of land in the vicinity of Caulfield. The company geologists are examining zinc mineralization at the Alice and Rex mines.

Iron.—Iron County ranked ninth in value of mineral output and second in lead concentrate production. St. Joseph Lead Co. mined over 440,000 tons of lead ore at the Viburnum No. 28 shaft. Ore from Nos. 28 and 27 production shafts was processed at the Virburnum Mill, the resultant concentrates were trucked to a Missouri-Pacific Railroad rail center near Middlebrook, and then carried by rail to the Herculaneum smelter, some 70 miles away. Building and monumental stone was prepared at the quarry of Heywood Granite Co. near Graniteville.

Jackson.—The county ranked fifth in value of mineral output, third in production value of cement and stone, and sixth in sand and gravel production. Residential and industrial construction in the area required large quantities of stone as well as sand and gravel accounting for a slight increase in production. Missouri Portland Cement Co. manufactured portland and masonry cement at its Sugar Creek plant near Independence; limestone and shale were obtained from company-operated quarries. Limestone was quarried and crushed for aglime, concrete aggregate, riprap, and roadstone by 9 commercial and 1 Government-and-contractor operation at 11 locations. George and Clark Stone Contractors prepared dimension limestone for rough construction, rough architectural, and dressed building stone. Gerald Hodgins Building Rock Quarries produced building stone and rubble. Stewart Sand & Material Co. produced building sand. Miscellaneous clay was mined for manufacture of heavy clay products by Acme Brick Co. Crude vermiculite shipped from Libby, Mont., was ex-

foliated at the Zonolite Co., Kansas City plant; output was lower than in 1962. Two oil pools, Boten and Longview, produced 3,400 barrels of petroleum from 21 wells.

Jasper.—The county ranked third in production value of stone and fourth in value of sand and gravel. Limestone was quarried and crushed for aglime, concrete aggregate, roadstone, and other purposes by Carthage Crushed Limestone Co. and Independent Gravel Co. Carthage Marble Corp. quarried marble for rough building stone, dressed building stone, monumental stone, and crushed stone. Chat was sold for railroad ballast, roofing granules, and other uses by American Zinc, Lead and Smelting Co. and Independent Gravel Co. Farmers Chemical Co. was expanding its ammonia phosphate plant near Joplin at a cost of $3 million; employment will be increased by 30 workers. Independent Gravel Co. processed sand for grinding and polishing, sandblasting, and for other purposes and processed gravel for paving and railroad ballast.

Jefferson.—Minerals produced in Jefferson County were sand and gravel and stone; value of output rose 4 percent. The county ranked second in value of sand and gravel production. Pittsburgh Plate Glass Co., Master Bros. Silica Sand Co., and Manley Sand Division of Martin-Marietta Corp. produced unground, high-purity silica sand for use in plate glass manufacturing, molding, grinding, and polishing. Building sand and gravel was produced by Ficken Material Co. near Cedar Hill. Jefferson County Highway Department produced paving gravel. Limestone was quarried and crushed for aglime, concrete aggregate, roadstone, and riprap by seven commercial operators and one Government-and-contractor operator. Marble was quarried for various uses, including terrazzo, by Marble Products Co. Mississippi River Fuel Corp. started constructing a 6 million-barrel-capacity portland cement plant near Selma; estimated cost of the plant was $25 million. Initial annual production will be 3 million barrels with employment estimated at 100 workers. Shipments will be made by barge and rail to distribution centers in St. Louis and other major cities. At yearend, the plant site had been surveyed, the quarry had been opened, and the required rail and road facilities had been constructed. All basic raw materials necessary for manufacturing cement are available at the plant site; fuel will be supplied by the company's pipeline division.

Johnson.—Increased stone production was generated by an active roadbuilding program. J. A. Tobin, Marr Bros. Quarry, and Deitz-Hill Development Co. mined and crushed limestone for aglime, concrete aggregate, and roadstone.

Knox.—Value of stone output, the only mineral produced, increased 4 percent. Knox County Stone Co., Inc., and McSorley Lime & Rock Co. mined and crushed limestone for aglime, concrete aggregate, and roadstone.

Laclede.—E. D. Rush opened a dolomitic limestone quarry. Missouri State Highway Department contracted for paving gravel.

Lafayette.—Increased production of stone accounted for a 28-percent increase in total mineral value. Deitz-Hill Development Co. operated two quarries and crushed limestone for aglime, concrete aggregate, and roadstone. Riprap was produced at a quarry operated by Red

Stone Co. Glasgow Sand Co. and Raymond Drivers Sand Co. processed sand for building, paving, and fill. F. W. Goodloe Coal Co. mined coal underground for local use.

Lawrence.—Two Government-and-contractor operations supplied concrete aggregate and roadstone to Missouri State Highway Department. Dimension limestone for rough architectural purposes was produced by Republic Stone Co. Paving gravel was processed for Missouri State Highway Department.

Lewis.—The county ranked seventh in value of sand and gravel production. Missouri Gravel Co. produced sand and gravel for building and paving. Two quarries of Hamill Lime Co. mined and crushed limestone for aglime, concrete aggregate, riprap, and roadstone.

Lincoln.—Increased demand for sand and gravel and stone for road maintenance accounted for a 44-percent increase in total mineral value. Kimaterials and Glacial Sand & Gravel Co. produced sand and gravel for building, paving, and fill. Paving gravel was produced for Missouri State Highway Department. Limestone was quarried and crushed for aglime, concrete aggregate, riprap, and roadstone by Dawson Dameron, Lincoln Quarry, and Watson Quarry, Inc. Fire clay was mined near Whiteside and processed into firebrick and block, high-alumina brick, and mortar by Harbison-Walker Refractory Co.

Linn.—Stone was the only mineral produced; value of output approximated that of 1962. Bailey Limestone Co. quarried and crushed limestone for aglime, concrete aggregate, and roadstone.

Livingston.—Farmers Rock & Lime Co., Inc., Fred McVey Quarry, Trager Quarries, Inc., and Frank Tagger mined and crushed limestone for aglime, concrete aggregate, roadstone, and riprap. Miscellaneous clay was mined and processed into heavy clay products by Midland Brick & Tile Co. near Utica. Cooley Gravel Co. produced sand for building and railroad sand. Paving sand was produced for Missouri State Highway Department.

Macon.—The county ranked second in coal production. Coal was strip-mined by Peabody Coal Co. at its Bee-Veer mine. The Schneider strip mine near Macon produced less than 1,000 tons of coal.

Maries.—Mineral commodities produced in Maries County were stone as well as sand and gravel. Valued output rose 21 percent over that of 1962. Increased production of sand and gravel accounted for a 21-percent gain in value. Smith Quarries mined and crushed limestone for aglime, concrete aggregate, and roadstone. Missouri State Highway Department contracted for paving sand and gravel.

Marion.—Total mineral production value increased 11 percent. Marblehead Lime Co. produced hydrated lime and quicklime at its Hannibal plant, using limestone quarried nearby. The company also produced limestone for asphalt filler and mineral food. S. D. Fessenden and Sons quarried and crushed limestone for aglime, concrete aggregate, and roadstone.

McDonald.—Missouri State Highway Department contracted for paving gravel. Frances Reeves quarried and crushed limestone for road surfacing material.

Mercer.—Stark-Cole Quarry and Twin State Quarries, Inc., mined and crushed limestone for aglime, concrete aggregate, riprap, and roadstone.

Miller.—Increased production of sand and gravel for road maintenance accounted for a 34-percent gain in mineral production value. Sand and gravel was produced for building, paving, and railroad ballast by C. W. Roweth Co. and Elam Construction Co., Inc. A small amount of barite was produced by the Kagee Mining Co., Inc.

Moniteau.—Moniteau County Agricultural Improvement Association, Inc., mined and crushed limestone for aglime, concrete aggregate, and roadstone. Missouri State Highway Department contracted for paving gravel.

Monroe.—The county ranked fifth in value of fire clays produced. Christy Firebrick Co. and Walsh Refractories Corp. mined clay to manufacture firebrick and block. Gilliam Mining Co. furnished fire clay for use in horizontal zinc retorts. Limestone was quarried and crushed for aglime, concrete aggregate, and roadstone by Central Stone Co., Hamilton Lime Co., and Wilkerson Bros. Paving gravel was produced by Wilkerson Bros.

Montgomery.—The county ranked fourth in value of fire clay output. Limestone was mined and crushed for aglime, concrete aggregate, and roadstone by McClain Lime Co. near Wellsville. Fire clay was mined at five locations by General Refractories Co., Kaiser Refractories & Chemical Co., and Wellsville Fire Brick Co. for use in manufacturing firebrick and block. Sand and gravel was produced for building and paving by Two Rivers Sand & Gravel Co. and for Missouri State Highway Department.

Newton.—Southwest Lime Co. mined and crushed limestone near Neosho for aglime, concrete aggregate, and roadstone. The American Tripoli Division of the Carborundum Co. processed tripoli at its Seneca plant for use as an abrasive and foundry facings; crude material was mined in Ottawa County, Okla. Output approximated that of last year.

Nodaway.—An active highway building program resulted in significantly increased stone production. Concrete Materials and Construction Co. quarried and crushed limestone for aglime, concrete aggregate, and roadstone. Sand and gravel for building and other uses was processed by Earl Wilson Sand Co.

Osage.—The county ranked sixth in value of fire clay production. A. P. Green Fire Brick Co. and Kaiser Refractories and Chemical Co. mined fire clay for manufacturing refractories. Paving gravel was produced by Osage County Highway Department.

Pemiscot.—Taylor Sand & Gravel Co. mined sand and gravel for building and paving near Caruthersville.

Perry.—Mineral production value was larger than in 1962. Increased stone production accounted for the high value and resulted from an active roadbuilding program in the area. Gibbar Bros., Inc., mined and crushed limestone for aglime, concrete aggregate, and roadstone near Perryville. The company also produced paving gravel.

Pettis.—Howard Construction Co. and W. J. Menefee Construction Co. quarried and crushed limestone for concrete aggregate and roadstone.

Phelps.—Increased production of fire clay accounted for a significant gain in total mineral value; the county ranked ninth in value of fire clay output. A. P. Green Fire Brick Co. and H. K. Porter Co., Inc.,

processed fire clay into refractories. Limestone was quarried and crushed for roadstone by Bray Construction Co. and Nivens Lime Quarry. Missouri State Highway Department contracted for paving gravel.

Pike.—Limestone was quarried and crushed for aglime, concrete aggregate, riprap, and roadstone at five locations by four companies; Hamill Lime Co. was the leading producer. Paving gravel was produced for Missouri State Highway Department. Hercules Powder Co. produced urea solutions, urea ammonium nitrate solutions, and prilled ammonium nitrate at its new plant near Louisiana.

Platte.—Stone production accounted for a 34-percent increase in total mineral value. Sandstone was quarried for riprap by Mid-Continent Stone & Construction Co. Everett Quarries, Inc., mined and crushed limestone for aglime, concrete aggregate, and roadstone. The county ranked fifth in miscellaneous clay output. Carter-Waters Corp. mined shale for manufacturing lightweight aggregate. One oil pool, Belgium Bottoms, produced an estimated 500 barrels of oil in 1963.

Pulaski.—Randal E. Norrell and Big Piney Sand Co. produced sand and gravel for building and paving. Missouri State Highway Department contracted for paving gravel.

Putnam.—The county ranked fifth in value of coal output. Coal was mined underground by Rowland Coal Co. and Henry T. Clark Coal Co. Husted Bros. strip-mined coal; Kirksville Coal Co. produced coal by strip-mining and auger mining methods. Limestone was mined and crushed for aglime and roadstone by Bailey Limestone Co., Inc.

Ralls.—The county ranked sixth in value of mineral output, fourth in cement, and ninth in stone production. Universal Atlas Cement, Division of United States Steel Corp., manufactured masonry and portland cement, using raw materials from company operated limestone and shale quarries. Central Stone Co. mined and crushed limestone for aglime, concrete aggregate, and roadstone. Paving gravel was produced by Edward B. Cooper near New London. Universal Atlas Cement Co. awarded a contract for detailed design and engineering service to modernize and enlarge cement producing facilities at the Hannibal plant; the present 14-kiln dry-process plant will be replaced with a single-kiln wet-process plant. New and enlarged barge loading facilities will be established at key market centers along the Mississippi River.

Randolph.—Glasgow Quarries, Inc., Potter Stone Quarry, and N. J. Cooksey Quarry Co. mined and crushed limestone for aglime, concrete aggregate, and roadstone. Coal for local use was produced at the underground mine of Fateley Coal Co. and the open pit mine of Lewis Mabry Coal Co.

Ray.—An active roadbuilding program in the area utilized large quantities of rock and accounted for a significant increase. Orrick Stone Co. and Steva Stone Co. mined and crushed limestone for aglime, concrete aggregate, roadstone, and riprap.

Reynolds.—Exploration continued on a large scale in the county. St. Joseph Lead Co. started developing a new lead mine and constructing a mill near Bunker. Paving gravel was produced for Missouri

State Highway Department. Two Government-and-contractor operators quarried a small quantity of limestone.

St. Charles.—The county ranked ninth in value of crushed limestone and third in sand and gravel production. Limestone was mined and crushed for aglime, concrete aggregate, riprap, and roadstone by five quarry operators; St. Charles Quarry Co. was the largest producer. Tavern Rock Sand Co. mined sand for use in manufacturing glass, molding, ferrosilicon, and other industrial sands. Paving gravel was produced for Missouri State Highway Department. Fire clay and miscellaneous clay were mined and processed into firebrick and block by General Refractories Co. and Highland Fire Clay Co. Monsanto Co. undertook a multimillion-dollar expansion project at its electronic chemical plant near St. Charles.

St. Clair.—The county ranked fourth in coal output. Coal was strip-mined by Pittsburg & Midway Coal Mining Co. at its Pioneer mine near Appleton. Limestone was quarried and crushed for aglime, concrete aggregate, and roadstone by George M. Baker Co. and Hunt Limestone Co. Paving gravel was produced for Missouri State Highway Department.

St. Francois.—Mineral production was third highest in the State; iron and lead output ranked first and lime production was second. More than 2 million tons of lead ores was mined at St. Joseph's Federal mine near Flat River. The ore was processed at the company-operated Federal and Leadwood mills and the concentrate was shipped via Missouri Pacific Railroad to the Herculaneum Smelter. The Hanna Mining Co. (Missouri Division) mined iron ore at its Iron Mountain mine; its entire production went to Granite City Steel Co. Valley Dolomite Corp. produced dead burned dolomite for refractory purposes at its Desloge plant. St. Joseph Lead Co. (Bonne Terre and Flat River quarries) and Valley Dolomite Corp. mined and crushed limestone for aglime, concrete aggregate, refractory purposes, roadstone, railroad ballast, and other purposes. Chat from lead and iron ore milling was used mainly for concrete aggregate, roadstone, railroad ballast, and fluxing; producers included St. Joseph Lead Co. and Trap Rock Material & Engineering Co. Sand and gravel was mined for building purposes by Mount Sand & Gravel Co. near Leadwood.

Ste. Genevieve.—The county ranked second in total mineral production and first in output of lime and stone. Mississippi Lime Co. mined limestone for making hydrated lime and quicklime at its Ste. Genevieve plant. The company also sold crushed limestone for glass, whiting, poultry grit, coal mine rock dust, asphalt filler, flux, aglime, concrete aggregate, and roadstone. Cliffdale Quarry & Manufacturing Co. and Menefee Crushed Stone Co., Inc., operated limestone quarries to produce aglime, concrete aggregate, riprap, and roadstone. Dimension marble was prepared for rough building purposes by Tennessee Marble Co. and Weiler Marble Co. Sand and gravel was produced for building and paving by Ed L. Bauman. New quarry and dock facilities were developed near Bloomsdale by the Menefee Crushed Stone Co., Inc. Rock will be barged to the company's Memphis crushing and screening plant. Crush rock products will be sold primarily in the Shelby County, Tenn., area.

St. Louis.—The county ranked first in cement, sand and gravel, and total mineral production value and second in value of stone output. Alpha Portland Cement Co. and Missouri Portland Cement Co. manufactured portland and masonry cement and utilized limestone and shale from company-operated quarries in the area. Stone was produced at 14 commercial operations. Crushed limestone was sold for aglime, concrete aggregate, riprap, railroad ballast, and roadstone; largest producers were Bussen Quarries, Inc., Vigus Quarries, Inc., and West Lake Quarry & Material Co.

Dimension limestone was prepared for building purposes by Riverview Stone & Material Co. and West Lake Quarry & Material Co. Unground and ground industrial sand was produced for manufacturing purposes. Leading sand and gravel producers were Pioneer Silica Products Co., Winter Bros. Material Co., St. Charles Sand Co., Missouri Aggregates, Inc., and Norman Brothers, Inc. Miscellaneous shale was mined for heavy clay products by Atlas Brick Co., U.S. Dickey Clay Manufacturing Co., and Hydraulic Press Brick Co. Fire clay was utilized to make refractories by the Refractories Division of H. K. Porter Co., Inc. Columbian Carbon Co., a subsidiary of Cities Service Co., announced construction of a multimillion-dollar plant for production of synthetic iron oxides. Completion was scheduled for late 1964. The Monsanto Co. began operating a new chlorine plant with a capacity of 100 tons of chlorine and 110 tons of caustic soda per day. Also, the company announced construction of facilities for production of ACL–59, a chemical of the chlorinated cyamuric acid family. Crude perlite, shipped from Colorado and New Mexico, was expanded at the plant of J. J. Brouk & Co. in St. Louis; output was less than in 1962. Vermiculite was exfoliated for plaster, concrete, and loosefill insulation at a Zonolite Co. plant; both quantity and value of output increased. The Florrissant pool produced 37,842 barrels of oil from 39 wells.

Saline.—The county ranked eighth in value of stone output. Limestone was mined and crushed for aglime, concrete aggregate, riprap, and roadstone at five operations by four companies; Mid-Continent Stone & Construction Co. mined sandstone for riprap.

Scotland.—Kaser Construction Co., a new limestone producer employing about 10 workers, operated a quarry and produced aglime, concrete aggregate, and road surfacing.

Scott.—West Lake Quarry & Material Co. quarried and crushed limestone for aglime, concrete aggregate, riprap, and roadstone. Surman & Sons Farm Supply distributed anhydrous ammonia at its new plant near Chaffee.

Shannon.—Limestone was mined and crushed for aglime by Crider Bros. Lime Co. near Eminence. Ozark Stone Products, Inc., prepared dimension sandstone for building purposes. Brown iron ore was mined for chemical uses. Ozark Lead Co., a subsidiary of Kennecott Copper Corp., continued extensive drilling on optioned land near Eminence.

Shelby.—Central Stone Co. and Turner Lime & Rock Quarry Co. mined and crushed limestone for aglime, concrete aggregate, and roadstone.

Taney.—Limestone was mined and crushed for aglime, concrete aggregate, riprap, and roadstone by Poulin & Son Rock & Lime Co. near Branson. Paving gravel was produced for Missouri State Highway Department.

Texas.—Missouri State Highway Department contracted for paving sand. Frisco Railroad became the first major rail line in the country to install precast concrete ties under continuous welded rails on curved, high-speed main line tracks; the procedure was being tested on a half-mile section of track near Cabool.

Vernon.—Limestone was mined and crushed for aglime, concrete aggregate, and roadstone by George Baker and Jones Coal & Rock Co. Dimension sandstone was prepared for building purposes by Missouri Native Stone Corp. Five small strip operations produced coal for local trade; larger companies were Ellis Coal Co., Garrett Coal Co., and Nichols Coal Co. (formerly Schooley Coal Co.). Paving gravel was produced by Montevallo Township Road Department and Osage Township Road Department. Two small oil pools produced an estimated 1,500 barrels of oil from 20 wells.

Warren.—The county ranked seventh in value of fire clay output. Harbison-Walker Refractory Co. mined clay near Turner for manufacturing firebrick and block, high-alumina brick, and mortar. Limestone was quarried and crushed for aglime, concrete aggregate, and roadstone by Sprick Quarry and Jeff-Cole Quarries, Inc. Paving gravel was produced by Warren County Department of Roads and for Missouri State Highway Department.

Washington.—Washington County ranked first in barite output and seventh in total mineral production value in the State. The barite came from 15 mines operated by 11 companies; leading producers were Milwhite Mud Sales Co., Magnet Cove Barium Corp., General Barite Co., DeSoto Mining Co., and National Lead Co. More than 350,000 tons of lead ore was produced at the St. Joseph Co. Indian Creek mine. C. K. Williams & Co. produced paving and railroad gravel near Mineral Point. Development of the Pea Ridge iron ore deposits was approaching the production stage; the first carload shipment of pellets was expected to be made early in 1964. Sinking of Viburnum No. 29 production shaft in south Washington County continued; hoisting ore on a production basis is scheduled for mid-1964.

Wayne.—Building sand and gravel was produced by Williamsville Stone Co. near Poplar Bluff. Missouri State Highway Department contracted for paving sand. Harris Lime Co. quarried and crushed limestone to produce road-surfacing material. A small tonnage of brown iron ore was mined at two pits and shipped to Tennessee Products & Chemical Corp.

Webster.—Sand and gravel and stone were produced; no mineral output was reported in 1962. Missouri State Highway Department contracted for paving gravel. Limestone was mined and crushed for use as road-surfacing material by S. P. Johnson Quarry Co.

Wright.—W. H. Bennett Quarries, Inc., mined and crushed limestone for aglime, concrete aggregate, and roadstone. Missouri State Highway Department contracted for paving gravel.

The Mineral Industry of Montana

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Montana Bureau of Mines and Geology, for collecting information on all minerals except fuels.

By Richard W. Knostman [1] and A. J. Kauffman, Jr.[2]

TOTAL value of mineral output for Montana decreased to $182 million in 1963 from $191 million in 1962. The output and value of most mineral commodities declined. Copper output-value fell $8.8 million because of production time lost during the transfer of mill equipment from Anaconda to a new concentrator at Butte. Value of zinc production dropped $1.1 million due to reduced output from the Badger State mine at Butte and the cessation of zinc mining by Trout Mining Co. and Taylor-Knapp Co. in the Philipsburg area. Lead production, mainly a byproduct of zinc mining, declined slightly in value compared with the 1962 total. Silver value, mainly from copper and zinc ores, was $500,000 higher. An increase in the average market price for silver resulted in an increased total value for this commodity despite lower production. The major nonmetal commodities registering declines were crude petroleum ($1.4 million) and sand and gravel ($3.9 million).

Stone and cement were the major nonmetal commodities with substantial gains in value and output over the 1962 totals. Most of the stone production increase was due to the State highway department reporting certain production for the first time. Cement output was raised to meet increased demand for concrete at the site for the Yellowtail Dam on the Big Horn River. Crude petroleum, copper, and sand and gravel contributed 76 percent of the State total value of mineral production.

By yearend, The Anaconda Company had nearly completed constructing the new 42,000-ton-per-day concentrator adjacent to the Berkeley pit at Butte. Anaconda Aluminum Co. disclosed plans for expanding the annual capacity of its Columbia Falls primary aluminum plant from 67,500 tons to 100,000 tons to enable the company to meet increased metal demand.

In March, Permanente Cement Co. completed constructing its $10-million cement plant at Montana City in Jefferson County. Most of the initial output was to be used at the Yellowtail Dam. Montana

[1] Geologist, Bureau of Mines, Albany, Oreg.
[2] Chief, Albany Office of Mineral Resources, Bureau of Mines, Albany, Oreg.

747-416—64——42

TABLE 1.—Mineral production in Montana[1]

Mineral		1962		1963	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	thousand short tons	56	$77	38	$45
Coal (bituminous and lignite)	do	382	1,140	343	967
Copper (recoverable content of ores, etc.)	short tons	94,021	57,917	79,762	49,133
Gold (recoverable content of ores, etc.)	troy ounces	24,387	854	18,520	648
Iron ore (usable)	thousand long tons, gross weight	9	62	13	89
Lead (recoverable content of ores, etc.)	short tons	6,121	1,126	5,000	1,080
Lime	thousand short tons	104	1,049	114	1,290
Manganese ore and concentrate (35 percent or more Mn)	short tons, gross weight	24,758	(3)	5,260	(3)
Manganiferous ore and concentrate (5 to 35 percent Mn)	do	1,264	29	1,688	(3)
Natural gas	million cubic feet	29,955	2,217	30,026	2,253
Petroleum (crude)	thousand 42-gallon barrels	31,648	76,690	[4]30,875	[4]75,335
Sand and gravel	thousand short tons	18,473	17,642	14,319	13,756
Silver (recoverable content of ores, etc.)	thousand troy ounces	4,561	4,948	4,242	5,426
Stone	thousand short tons	996	1,708	6,109	7,081
Zinc (recoverable content or ores, etc.)	short tons	37,678	8,666	32,941	7,576
Value of items that cannot be disclosed: Barite, cement, fluorspar, gem stones, gypsum, mica (1962), natural gas liquids, peat, phosphate rock, talc, thorite concentrate (1962), tungsten (1962), uranium ore, vermiculite, and values indicated by footnote 3			16,531		17,348
Total			190,656		182,027

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes fire clay; included with "Value of items that cannot be disclosed."
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Preliminary figure.

Phosphate Products Co. began work on a $6-million phosphate rock mining and beneficiating complex near Hall, Granite County.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$131,748	1958	$182,037
1953	140,487	1959	166,377
1954	133,074	1960	172,132
1955	158,033	1961	180,867
1956	189,175	1962	183,999
1957	187,912	1963	175,185

Consumption, Trade, and Markets.—Nearly all business indicators exhibited gains. Cement shipments from all sources to destinations in the State led with a 16-percent increase, which was due largely to concrete work at the Yellowtail Dam on the Big Horn River. Lumber and timber industries annual average employment advanced 8.8 percent in 1963. Farm cash income registered a 1.2-percent gain compared with a 17.2-percent gain in 1962. Personal income rose 1.2

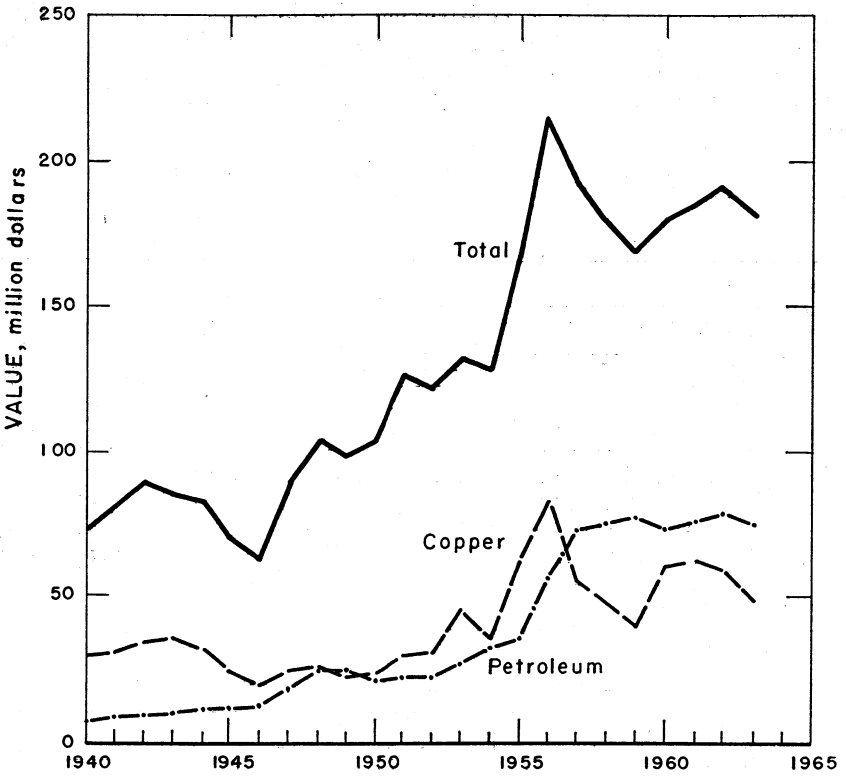


FIGURE 1.—Value of copper, petroleum, and total value of mineral production in Montana, 1940–63.

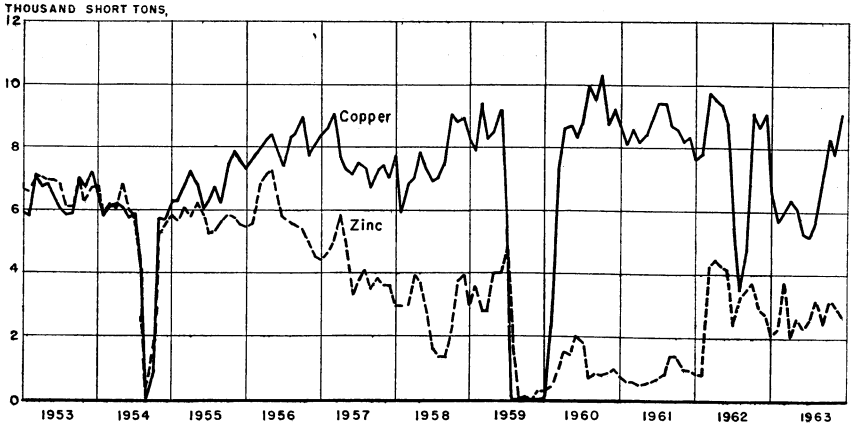


FIGURE 2.—Mine production of copper and zinc in Montana, 1953–63, by months, in terms of recoverable metals.

percent compared with a 17.4-percent rise in 1962. The only employment indicator with a decrease was transportation and utilities. This business segment was affected by the reduction of ore shipments from Butte to Anaconda and by a general curtailment in railroad employment.

TABLE 3.—Indicators of Montana business activity

	1962	1963 [1]	Change percent
Personal income:			
Total, million dollars	1,565.0	1,583.0	+1.2
Per capita, dollars	2,245.0	2,239.0	−0.3
Construction activity:			
Building permits, million dollars	29.9	31.6	+5.7
Heavy engineering awards, do	71.0	75.3	+6.1
Highway construction contracts awarded, do	45.0	48.1	+6.9
Cement shipments to and within Montana, thousand 376-pound barrels	1,291.5	1,497.5	+16.0
Cash receipts from farm marketings, million dollars	400.0	404.8	+1.2
Mineral production, do	191.0	182.0	−4.7
Annual average employment:			
Total nonagricultural industries, thousands	171.7	174.5	+1.6
Total manufacturing, do	22.0	22.5	+2.3
Lumber and timber industries, do	8.0	8.7	+8.8
Metal-mining and primary-metal industries, do	6.8	7.0	+2.9
Contract construction, do	12.6	12.9	+2.4
Transportation and utilities, do	17.9	17.7	−1.1

[1] Preliminary figures.

Source: Survey of Current Business, Construction Review, Pacific Builder & Engineer, Montana Highway Commission, The Farm Income Situation, Montana Labor Market, and Bureau of Mines.

TABLE 4.—Employment for selected mineral industries

Year	Total mining	Metal mining	Nonmetals, including coal	Petroleum and natural gas	Processing	
					Primary metals	Petroleum refining
1954–58 (average)	10,900	7,500	900	2,600	4,200	1,200
1959	7,800	4,600	700	2,500	3,100	900
1960	7,400	4,500	700	2,200	3,800	900
1961	7,100	4,200	700	2,200	3,600	1,000
1962	6,800	3,800	800	2,200	3,500	1,000
1963	7,000	4,100	900	2,000	3,200	1,200

Source: Montana State Employment Service, Montana Labor Market. Excludes proprietors and self-employed. Industry groups may vary from those in the Bureau of Mines canvass.

TABLE 5.—Hours and earnings data in mining and related industries

Industry	1959	1960	1961	1962	1963
Mining:					
Average weekly earnings	$101.91	$103.74	$108.14	$111.24	$113.85
Average weekly hours	40.6	39.9	40.2	41.2	41.2
Average hourly earnings	$2.51	$2.60	$2.69	$2.70	$2.77
Metal mining:					
Average weekly earnings	(1)	$101.79	$106.52	$107.25	$110.76
Average weekly hours	(1)	39.0	39.6	39.0	39.0
Average hourly earnings	(1)	$2.61	$2.69	$2.75	$2.84
Primary-metals processing:					
Average weekly earnings	(1)	$96.53	$102.40	$102.82	$105.74
Average weekly hours	(1)	39.4	40.0	39.7	39.9
Average hourly earnings	(1)	$2.45	$2.56	$2.59	$2.65

[1] Strike in metal-mining industry beginning Aug. 19, 1959, unsettled at yearend.

Source: Montana State Employment Service, Montana Labor Market. Hours and earnings data exclude administrative and salaried personnel. Average weekly and hourly earnings include overtime and other premium pay.

TABLE 6.—Employers, wage earners, and wages in mining

Fiscal year	Average number of employers	Average number of wage earners	Wages (thousands)	Average annual wage
1954–58 (average)	511	11,116	$56,363	$5,071
1959	416	8,722	46,017	5,276
1960	492	6,641	36,031	5,426
1961	480	7,453	44,092	5,916
1962	464	6,882	41,800	6,075
1963	421	6,837	43,107	6,316

Source: Unemployment Compensation Commission of Montana, Montana Labor Market. Industries and employment covered under unemployment insurance laws of Montana.

TABLE 7.—Employment and injuries in the mineral industries

Year and industry	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1962:						
Quarries and mills [1 2]	227	215	389,889	----------	5	13
Nonmetal mines and mills	648	234	1,213,332	----------	34	28
Sand and gravel operations [2]	212	135	228,569	1	7	35
Metal mines and mills	4,218	269	9,082,625	6	186	21
Coal mines	133	137	145,808	----------	5	34
Total	5,438	254	11,060,223	7	237	22
1963: [3]						
Quarries and mills [1 2]	258	235	484,656	1	5	12
Nonmetal mines and mills	712	243	1,386,388	1	44	32
Sand and gravel operations [2]	237	135	256,194	----------	6	23
Metal mines and mills	3,643	291	8,471,898	6	157	19
Coal mines	115	114	104,985	----------	1	10
Total	4,965	269	10,704,121	8	213	21

[1] Includes cement- and lime-processing plants.
[2] Includes only commercial operations.
[3] Preliminary figures.

Employment and Injuries.—An increase in mining employment from an annual average of 6,800 to 7,000 stopped a downward trend which started after the 1956 high of 12,400. The gain probably would have been greater except for a shortage of miners at Butte mines; a decrease of 200 in the petroleum and natural gas category also contributed. Near yearend, the Area Redevelopment Administration sponsored training classes in mining techniques to help alleviate the miner shortage. Employment in the mineral processing industry had a net loss of 100—primary metals processing declined 300, and petroleum refining gained 200. The principal factor causing the decline in annual employment in processing of primary metals was the transfer by The Anaconda Company of a major portion of its copper concentrating to the new, highly automated mill at Butte.

Injury statistics (table 7) were compiled from reports by mining companies to the Bureau of Mines.

Government Programs.—The Office of Minerals Exploration (OME) approved two new contracts—Grand Deposit Mining Co., Beaverhead County (gold, silver, bismuth, and tellurium) and Larrigon Mining Co., Ravalli County (gold). Costs of the contracts were $72,030 and $31,610, respectively, with Government participation of 50 percent.

The U.S. Geological Survey, in collaboration with the Montana Bureau of Mines and Geology, prepared a survey of the mineral and water resources of Montana.[3]

The Montana Bureau of Mines and Geology published a catalogue of unpublished geologic studies.[4]

Water.—The results of a 1962 survey of mineral industry water requirements (exclusive of smelters, refineries, and cement plants) showed that approximately 16.3 billion gallons of water (excluding petroleum and natural gas processing plants) was required in mining and processing mineral commodities. Approximately 69 percent of this total was required by metal mines and mills; 23 percent was used at nonmetal mines, quarries, and mills; 8 percent was required by sand and gravel operations and processing plants; and processing requirements for coal were less than 1 percent of the total.

Metal and nonmetal mining and milling operations utilized extensive water recirculating techniques through preplanned reuse of water from settling ponds, decanting towers, centrifuges, thickeners, and other dewatering devices common to the mineral processing industry. Approximately 79 percent (3 billion gallons) of the water requirements in nonmetal mining and milling (exclusive of sand and gravel operations) was from recirculated water, compared with 33 percent (3.7 billion gallons) of total water requirements from recirculated water for metal operations.

In addition to the total water requirements for mining and processing mineral commodities, approximately 147 million gallons of water was required in drilling for petroleum and natural gas, and 465 million gallons was utilized in petroleum waterflooding operations for secondary recovery of petroleum.

TABLE 8.—Water use by the mineral industry in 1962

(Million gallons)

Industry	New water	Recirculated water	Total water use	Water discharged	Water consumed
Metal mines and mills	7,564	3,700	11,264	6,906	658
Nonmetal mines and mills	779	3,000	3,779	745	34
Quarries and mills	41		41	37	4
Sand and gravel mines and processing plants	1,198	42	1,240	1,121	77
Coal (bituminous)	2	20	22	2	(1)
Total [2]	9,583	6,762	16,345	8,881	772

[1] Less than 500,000 gallons.
[2] Due to rounding, individual items may not add to totals shown.

[3] U.S. Geological Survey. Mineral and Water Resources of Montana. Prepared for the Committee on Interior and Insular Affairs, U.S. Senate. Montana Bureau of Mines and Geology, Special Publication 28, 1963, 166 pp.
[4] Chelini, J. M. Preliminary Index of Unpublished Geologic Studies in Montana. Special Publication 29, 1963, 81 pp.

TABLE 9.—Water injection and waste water disposal at secondary recovery operations in 1962

Source of water injected (Geologic formation)	Water injected into oil producing zone					
	Fresh water		Saline water		Saline water from oil wells	
	Number of wells	Barrels per year	Number of wells	Barrels per year	Number of wells	Barrels per year
Cretaceous:						
Fox Hills	4	1,560,000				
Eagle	5	585,855				
Kootenai (3rd Cat Creek member)	2	2,503,086				
Mississipian:						
Madison			15	1,999,349	116	2,712,616
Silurian-ordovician Interlake-Red River					152	897,000
Unclassified						
Total	11	4,648,941	15	1,999,349	268	3,609,616

Source of water injected (Geologic formation)	Waste water disposal by secondary recovery operators			
	Into waste water wells			Other disposal
	Disposal formation	Number of wells	Barrels per year	Barrels per year
Cretaceous:				
Fox Hills	Cretaceous Dakota.	2	5,739,251	
Eagle				
Kootenai (3rd Cat Creek member)				
Mississipian:				
Madison				
Silurian-ordovician Interlake-Red River				
Unclassified				182,256
Total		2	5,739,251	182,256

REVIEW BY MINERAL COMMODITIES

METALS

Aluminum.—Anaconda Aluminum Co. produced 67,354 tons of aluminum compared with 66,844 tons in 1962, according to The Anaconda Company annual report to share holders. Construction of a third potline, which would raise annual plant capacity from 67,500 tons to 100,000 tons, was initiated late in the year. Operation of the new potline, scheduled to begin in the third quarter of 1965, was expected to require an additional 200 employees.

At Anaconda, Deer Lodge County, The Anaconda Company alumina-from-clay pilot plant operation produced at a rate of 5 tons of alumina per day. This alumina, processed to aluminum at the Columbia Falls plant on a trial basis, was reported by the company to be comparable with bauxite-derived alumina.

Copper.—Production of copper dropped approximately 15 percent because of adjustments in operating schedules resulting from the transfer of equipment from The Anaconda Company copper mill at Anaconda to the new 42,000-ton-per-day Butte concentrator. Anaconda

produced all except 126 tons of the State output of 79,762 tons. Production from the Butte concentrator began in September, and milling operations were conducted both at Anaconda and Butte during the remainder of the year. Upon completion of the new plant, scheduled for 1964, milling of copper ore at Anaconda was to be terminated.

TABLE 10.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1954–58 (average)	123	11	8,710	29,735	$1,041	5,567	$5,038
1959	96	14	8,779	28,551	999	3,420	3,096
1960	129	13	12,317	45,922	1,607	3,607	3,265
1961	135	17	12,792	35,377	1,238	3,490	3,227
1962	107	5	11,835	24,387	854	4,561	4,948
1963	117	8	9,506	18,520	648	4,242	5,426
1862–1963			[3]	17,701,000	403,977	841,699	633,313

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	83,902	$56,120	14,445	$4,153	56,764	$13,572	$79,924
1959	65,911	40,469	7,672	1,765	27,848	6,405	52,734
1960	91,972	59,046	4,879	1,142	12,551	3,238	68,298
1961	104,000	62,400	2,643	544	10,262	2,360	69,770
1962	94,021	57,917	6,121	1,126	37,678	8,666	73,511
1963	79,762	49,133	5,000	1,080	32,941	7,576	63,864
1862–1963	7,858,000	2,648,251	928,000	145,350	2,742,000	521,853	4,352,744

[1] Includes recoverable metal content of gravel washed (placer mines), ore milled, old tailings re-treated, and ore, old slag, and copper precipitates shipped to smelters during the calendar year indicated. Owing to rounding, individual items may not add to totals shown.
[2] Does not include gravel washed.
[3] Data not available.

Production from the Berkeley pit declined 24 percent (11,106 tons) to 35,581 tons, while output from the Butte Hill mines (Mountain Con, Steward, and Leonard) increased 21 percent (7,073 tons) to 41,139 tons. Ore production at the Berkeley pit dropped from 35,128 tons per operating day in 1962 to 23,887 tons per day, and the amount of waste removed per ton of ore mined rose to 3.89 tons. Rock containing a minimum of 0.5 percent copper was considered ore, but that containing from 0.1 to 0.5 percent copper was hauled to special dumps for later recovery of a portion of the copper by leaching. Approximately 1,350 tons of copper was recovered from mine water proceessed at the Butte precipitation plant. The Kelley mine was not operated; 9,808 tons had been produced from the mine in 1962.

Gold.—Output of gold declined 24 percent (5,867 ounces) from the 1962 total, and production was the lowest on record (since 1900). The major portion of the output was as byproduct of copper (63 percent) and zinc (14 percent) production by The Anaconda Company. The largest gold-producing mine was the Berkeley pit (9,115 ounces); followed by the Anaconda zinc operations at Butte (2,627 ounces) and the Butte Hill mines (2,528 ounces). Other major production was

TABLE 11.—Mine production of gold, silver, copper, lead, and zinc in 1963, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines[1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Ore:							
Dry gold	23	3,598	1,245	1,313	2,300	500	1,800
Dry gold-silver	12	5,922	741	27,008	49,500	13,600	2,700
Dry silver	44	34,448	648	185,169	116,500	211,000	187,400
Total	79	43,968	2,634	213,490	168,300	225,100	191,900
Copper	9	8,139,535	11,742	2,477,756	153,463,900	8,400	1,000
Lead	15	2,593	228	11,975	12,300	575,800	101,500
Lead-zinc	6	154	3	2,146	800	118,700	24,800
Zinc	1	[2]1,206,614	2,627	1,471,934	3,125,800	6,370,000	48,280,000
Total	31	9,348,896	14,600	3,963,811	156,602,800	7,072,900	48,407,300
Other lode material:							
Dry gold-silver old tailings	5	11,167	1,181	31,453	17,100	45,800	88,100
Dry silver old tailings	4	5,102	49	32,862	28,300	----------	----------
Copper precipitates	1	----------	----------	----------	2,707,500	----------	----------
Zinc slag	1	97,094	----------	----------	----------	2,656,200	17,194,700
Total lode material	117	9,506,227	18,464	4,241,616	159,524,000	10,000,000	65,882,000
Placer	8	[3]	56	4	----------	----------	----------
Total	125	9,506,227	18,520	4,241,620	159,524,000	10,000,000	65,882,000

[1] Detail will not necessarily add to total, because some mines produce more than one class of material.
[2] Includes 60,970 tons of manganese ore containing gold, silver, copper, lead, and zinc.
[3] 7,505 cubic yards.

TABLE 12.—Gold production at placer mines

Year	Mechanical and hydraulic methods[1]			Small-scale hand methods			Total[2]		
	Number of mines	Material treated (thousand cubic yards)	Gold (troy ounces)	Number of mines	Material treated (thousand cubic yards)	Gold (troy ounces)	Number of mines	Material treated (thousand cubic yards)	Gold (troy ounces)
1954–58 (average)	6	263	1,609	[3]4	1	45	10	263	1,654
1959	9	157	973	5	4	29	14	161	1,002
1960	2	2	41	11	8	94	13	10	135
1961	5	30	82	12	4	50	17	34	132
1962	3	7	64	2	4	46	5	11	110
1963	[4]2	2	16	6	5	40	8	8	56

[1] Combined to avoid disclosing individual company confidential data.
[2] Owing to rounding, individual items may not add to totals shown.
[3] Includes surface and underground (drift) placers.
[4] Dragline dredges.

from the Rumsey mine, Granite County, and the Yellowband mine (Shafer group), Beaverhead County. Eight placer mines yielded 56 ounces, and the largest single output was from a Beaverhead County operation.

Several gold exploration programs were in progress during the year. Merger Mines, Ltd., Toronto, Ontario, explored the William Rogers Wade claims in the Marysville district, Lewis and Clark County. United Buffadison Mines, Ltd., also of Toronto, conducted exploration and development at the Crystal mine in the Cataract district of Jefferson County. Vitro Minerals Corp. obtained leases on 86 mining claims and two sections of State-owned land in the Judith

TABLE 13.—Mine production of gold, silver, copper, lead, and zinc in 1963, by counties, in terms of recoverable metals

County	Mines producing		Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
Beaverhead	13	1	960	$34	46,671	$60
Broadwater	5		29	1	130	(1)
Granite	14		1,369	48	127,393	163
Jefferson	14	1	611	21	73,822	94
Lewis and Clark	13		164	6	6,491	8
Liberty	1				194	(1)
Madison	9	1	810	28	14,205	18
Meagher	4	1	12	(1)	1,161	1
Mineral	1				7	(1)
Park	1		35	1	7	(1)
Powell	3	1	15	1	1,300	2
Silver Bow	10	2	14,287	500	3,951,004	5,054
Unassigned	15		157	5	1,622	2
Undistributed [2]	14	1	71	2	17,613	23
Total [3]	117	8	18,520	648	4,241,620	5,426

County	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
Beaverhead	9	$6	187	$40	35	$8	$147
Broadwater	(4)	(4)	(4)	(4)	(4)	(4)	2
Granite	52	32	(4)	(4)	(4)	(4)	244
Jefferson	18	11	111	24	107	25	175
Lewis and Clark	4	2	1,375	297	8,634	1,986	2,299
Liberty	1	1	4	1	1	(1)	2
Madison	(5)	(4)	(4)	(4)	(4)	(4)	60
Meagher	(4)	(4)	(4)	(4)	(4)	(4)	17
Mineral	1	(1)					(1)
Park							1
Powell	(5)	(1)	13	3	1	(1)	5
Silver Bow	79,636	49,056	3,185	688	24,140	5,552	60,850
Unassigned	7	4	2	(1)	1	(1)	13
Undistributed [2]	7	4	74	16	13	3	49
Total [3]	79,762	49,133	5,000	1,080	32,941	7,576	63,864

[1] Less than $500.
[2] Includes values and quantities that cannot be shown separately for Cascade, Deer Lodge, Flathead, Judith Basin, Missoula, Ravalli, and Sanders Counties.
[3] Owing to rounding, individual items may not add to totals shown.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Less than 0.5 ton.

Mountains near Lewistown and planned extensive exploration of the area. Grand Deposit Mining Co. was awarded a $72,030 Office of Minerals Exploration contract—$36,015 to be furnished by the Government—to explore for gold, silver, bismuth, and tellurium in the Bannack district of Beaverhead County. Larrigon Mining Co. received a $31,610 OME contract for work in Ravalli County. Northern Continental, Inc., continued exploring the Little Ben property in Phillips County. Northern Continental had received a $76,100 OME contract in 1962.

Iron Ore.—Production of iron ore was 13,297 long tons—4,096 long tons more than in 1962. The output was by Ralls & Harris Bros. from the Iron Cross (9,809 long tons) and Iron Magnet (3,488 long tons) open-pit mines near Radersburg, Broadwater County, for use by the cement industry.

TABLE 14.—Mine production of gold, silver, copper, lead, and zinc, in 1963, by types of material processed and methods of recovery, in terms of recoverable metals

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Amalgamation	55	10			
Concentration and smelting of concentrates	14,602	3,966,948	156,571,200	6,388,300	48,288,500
Total	14,657	3,966,958	156,571,200	6,388,300	48,288,500
Direct smelting:					
Ore	2,577	210,343	199,900	909,700	310,700
Old tailings	1,230	64,315	45,400	45,800	88,100
Copper precipitates			2,707,500		
Old slag				2,656,200	17,194,700
Total	3,807	274,658	2,952,800	3,611,700	17,593,500
Placer	56	4			
Grand total	18,520	4,241,620	159,524,000	10,000,000	65,882,000

Lead.—Production of lead declined 18 percent below the 1962 total and was mostly a byproduct of zinc output. The Anaconda Company Badger State block-caving operation at Butte and the East Helena slag-fuming operation accounted for the major portion of the State output. Lead also was recovered by processing material from various mine dumps and small open pits in the Silver Summit district and from the purchased Government low-grade manganese stockpile. Of the 487 tons not produced by Anaconda Company operations, the largest single portion (177 tons) was from the Maulden mine of Ida B. Hand, Beaverhead County.

Payments to operators of small lead-zinc mines totaled $10,785 for producing 196 tons of leads ($10,342) and 16 tons of zinc ($443) under the Government program to stabilize the mining of lead and zinc by small producers. Operators were certified as eligible to receive payments on 1,469 tons of lead and 196 tons of zinc, but production by these operators was far below the eligible amounts. Four operators were certified as eligible to receive payments in 1964.

Manganese.—Shipments of manganese ore and concentrate (35 percent or more manganese) totaled 5,260 short tons, a 19,498-ton decline from that of 1962. Manganiferous ore and concentrate (5 to 35 percent manganese) shipments decreased to 1,688 tons.

As in 1962, the Anaconda Company did not mine manganese ore but shipped metallurgical-grade nodules from stocks. Low-grade manganese raw material from a Government stockpile purchased by the company in 1962 was concentrated at the Anaconda Reduction Works. No ferromanganese or manganese nodules were produced.

Taylor-Knapp Co. mined 7,635 long tons of ore from the Moorlight group near Philipsburg, Granite County. The company, the only domestic producer of manganese dioxide suitable for use in dry-cell batteries, shipped concentrate containing 40.5 percent manganese to battery manufacturers and manganiferous concentrate containing 32.5 percent manganese to uranium processors, electrolytic zinc plants, and other metallurgical operations.

The General Services Administration invited bids on approximately 230,000 tons of manganese oxide and mixed oxide-carbonate ores stockpiled at Butte; however, no acceptable responses were received.

Silver.—A 7-percent decline in silver output was accompanied by a 10-percent gain in production value due to the increased market price. Output declined to 4.2 million ounces while the value rose to $5.4 million. The Anaconda Company accounted for 3.95 million ounces as a byproduct of copper and zinc ores originating at Butte operations. The largest production outside of Silver Bow County was from Granite County (127,393 ounces).

Thorium.—There was continued interest in developing thorium-bearing properties in the Lemhi Pass area of Beaverhead County. The Montana State Land Board granted a thorium-mining lease on more than 1,200 acres in southwestern Beaverhead County. The State was to receive a royalty of 5 percent of the production value and a rental fee of $925 per year ($0.75 per acre). A study of thorium deposits in the Lemhi Pass area of Idaho and Montana was published by the U.S. Geological Survey.[5]

Uranium.—Production of uranium ore declined sharply from that of 1962 and was very small compared with the record 2,890 tons mined in 1959. All production was by Pryor Mining Co. from the Old Glory mine, Carbon County.

Zinc.—Output of zinc declined 4,737 tons (13 percent) below the 1962 production of 37,678 tons. Reduced production from The Anaconda Company Badger State mine, the largest zinc mine in the State, and the idleness of two former producers in the Philipsburg area of Granite County—Trout Mining Co. and Taylor-Knapp Co.—account for the drop in output. Anaconda operations in the Silver Summit (Butte) district and the slag-fuming operation, adjacent to the American Smelting and Refining Company lead smelter at East Helena, accounted for all except 204 tons of the State output. Mines in Jefferson County supplied 107 tons.

In an effort to obtain enough zinc raw material for efficient operations at the Anaconda zinc concentrator and the Great Falls electrolytic zinc plant, The Anaconda Company supplemented production from the Badger State block-caving operation by mining ore from two small pits and shipping from several mine dumps in the Silver Summit district. Strip mining was conducted during part of the year at the Orphan Girl and Syndicate pits, and low-grade material was shipped from the Anselmo, Colorado (Steward mine), Orphan Girl, Otisco (Belmont mine), and Paymaster (Lexington mine) dumps. Zinc also was recovered from Government low-grade manganese stockpile material purchased in 1962.

Previously announced plans for constructing a new 4,000-ton-per-day zinc concentrator at Butte, to replace the one at the Anaconda Reduction Works at Anaconda, were shelved.

A shortage of concentrates, which resulted from reduced output from company mines and from increased competition for raw material among zinc smelters in the World, forced The Anaconda Company to

[5] Sharp, W. N. and W. S. Cavender. Geology of Thorium-Bearing Deposits in the Lemhi Pass Area, Lemhi County, Idaho, and Beaverhead County, Mont. U.S. Geol. Survey Bull. 1126, (1962) 1963, 76 pp.

reduce its Great Falls zinc plant operation from seven to six units on April 1. Slab zinc production totaled 121,084 tons, compared with 133,462 tons in 1962. Annual plant capacity was 162,000 tons, the second largest in the world.

NONMETALS

Asbestos.—A method for recovering short-fiber tremolite asbestos as a coproduct with vermiculite was tested by Zonolite Division, W. R. Grace & Co. at Libby, Lincoln County. The asbestos was separated from the vermiculite by a wet-milling process. In past years, the company purchased large quantities of a similar product.

Barite.—There was an increase in the quantity and value of barite production compared with the 1962 totals. Output, mined and ground near Greenough, Missoula County, by Baroid Sales Division, National Lead Co., was marketed mainly as a weighting agent in oil well drilling mud.

Cement.—There was a sharp increase in the quantity and value of cement shipments, in comparison with 1962 shipments, resulting from output from a new plant. Destinations within the State accounted for about 72 percent of the cement sales; shipments also were made to North Dakota, Utah, Wyoming, Idaho, and Colorado.

Storage capacity at the Ideal Cement Co. Trident plant was increased to 300,000 barrels in midsummer with completion of several new concrete silos.

Initial cement output was made at the Montana City plant of Permanente Cement Co. (Jefferson County). Construction of the $10 million facility, which began in April 1962, was completed early in March. Most of the output was used at the Yellowtail Dam on the Big Horn River. Plans were announced to market cement in other areas of Montana, as well as in other Rocky Mountain and Midwestern States.

Clays.—Total clay output was much lower than in 1962. The drop was attributed to decreased production of miscellaneous clay and shale. The quantity of fire clay mined, although relatively small, was about double the 1962 output. Miscellaneous clay for making heavy clay products came from Fergus and Yellowstone Counties. Two companies—Treasurelite Division, Treasure State Industrial Products, Inc., (Cascade County) and Montana Liteweight Aggregate Co. (Yellowstone County)—produced and expanded shale for use as lightweight aggregate. Fire clay for making firebrick, fireblock, and saggers was dug in Cascade County.

Fluorspar.—Roberts Mining Co. continued to produce fluorspar at its Crystal Mountain mine in Ravalli County. The major consumer, as in past years, was the steel industry.

Gypsum.—Output and value of crude gypsum mined increased about 25 percent compared with 1962 totals. Two mines in Fergus County furnished the production, most of which was calcined and sold as ground gypsum; some was used to make wallboard and lath. Uncalcined gypsum was used as a retarder in portland cement.

Lime.—Output of lime increased 10 percent in quantity and 23 percent in value compared with 1962 totals. Three companies operating

sugar refineries in Big Horn, Missoula, Richland, and Yellowstone Counties calcined limestone for their own use. Quicklime was also produced in Deer Lodge and Powell Counties.

Phosphate Rock.—The quantity and value of marketable phosphate rock produced increased 15 and 16 percent, respectively, over the corresponding 1962 values. Mining was conducted in Beaverhead, Powell, and Silver Bow Counties; some of the output was exported to British Columbia for use in making phosphate fertilizers. Elemental phosphorus was made at Silver Bow from Beaverhead and Silver Bow County rock.

Montana Phosphate Products Co. completed considerable development at its Douglas mine in the Maxville-Philipsburg area of Granite County and began constructing a beneficiation plant near Hall. The company, a subsidiary of Consolidated Mining & Smelting Co. of Canada, Ltd., Trail, British Columbia, planned to spend $6 million on the project. Work at the mine consisted of driving five adits to gain access to the phosphate-bearing strata. At the plant, which was to have an annual capacity of 300,000 tons of 31 percent P_2O_5 concentrate, rock trucked from the mine was to be beneficiated by a flotation process before shipping to Trail and Kimberly in closed-hopper rail cars.

Rocky Mountain Phosphates, Inc., began making a defluorinated phosphate product at its new Garrison plant for use as a feed supplement for livestock and poultry. The company formerly operated a similar plant at Butte.

Sand and Gravel.—Output of this construction material decreased to 14.3 million tons from 18.5 million in 1962; value dropped to $13.8 million from $17.6 million during the same period. Curtailed requirements by the Bureau of Public Roads and the Montana State Highway Department resulted in the decrease. Requirements of the Bureau of Reclamation Yellowtail Dam project totaled more than 1 million tons. Of the total output, 2.9 million tons was credited to commercial producers, and 11.4 million tons was furnished by Government-and-contractors operations. Uses did not change from 1962; the distribution was road material, 91 percent; building, 5 percent; miscellaneous, including fill and railroad ballast, 4 percent.

Stone.—Compared with 1962 totals, output and value of stone increased to 5.1 million tons and $5.4 million, respectively. The apparent increase to 6.1 million tons and $7.1 million was due to a more complete report showing production of 4.7 million tons ($4.9 million) for the Montana State Highway Department. That agency had not reported its contracted stone output in previous years. Miscellaneous stone, the principal stone quarried, was obtained largely from the Belt Series, Fort Union, Lance, and Morrison geologic formations. Limestone, ranking second in quantity produced, was used for making cement and lime. Smaller quantities of sandstone, granite, and marble also were quarried. Miscellaneous stone was mined in 34 counties; Dawson, Yellowstone, and Lewis and Clark Counties each had output in excess of 400,000 tons. Gallatin, Jefferson, and Deer Lodge Counties were the source of most of the limestone output. Most of the sandstone was quarried in Missoula County.

TABLE 15.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	949	$1,373	721	$1,057
Road material	599	538	1,707	1,641
Fill	233	264	240	167
Railroad ballast	(1)	(1)	131	82
Other [2]	343	231	73	72
Total	2,124	2,407	2,872	3,018
Government-and-contractor operations:				
Building	57	147		
Road material	16,157	14,978	11,350	10,678
Fill	118	93	69	45
Other [2]	17	17	27	15
Total	16,349	15,235	11,446	10,738
All operations:				
Building	1,006	1,520	721	1,057
Road material	16,756	15,516	13,057	12,319
Fill	350	357	309	211
Railroad ballast	(1)	(1)	131	82
Other [2]	361	248	101	87
Grand total [3]	18,473	17,642	14,319	13,756

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Sand and gravel used for miscellaneous and unspecified purposes, including items indicated by footnote 1.
[3] Data may not add to totals shown because of rounding.

Sulfur.—Production of high-purity sulfur from refinery gases was lower than in 1962. Two oil refineries near Billings, Yellowstone County, provided the raw material to the Montana Sulphur & Chemical Co. plant.

Talc.—There was a 34- and 36-percent increase, respectively, in the quantity and value of talc output compared with the 1962 totals. Four companies accounted for the production, most of which was ground at mills in Beaverhead, Gallatin, and Lewis and Clark Counties. Talc also was shipped for grinding at plants at Grand Island, Nebr.; Ogden, Utah; and Los Angeles, Calif.

There was a significant change in the quantity of talc used in paint; uses were as follows (1962 percentages are in parentheses): Paint, 33 percent (47 percent); paper, 32 percent (34 percent); ceramics, 11 percent (14 percent); and exports and miscellaneous including insecticides, textiles, rice polishing, and rubber, 24 percent (5 percent).

Sierra Talc Co. continued its grinding plant modernization program at Three Forks.

Vermiculite.—Crude vermiculite production was about 12 percent higher than in 1962. Zonolite Division, W. R. Grace & Co., continued to operate its open pit, the principal source of vermiculite in the Nation, at Libby, Lincoln County. Some of the output was exfoliated by a company in Great Falls, Cascade County, but most was shipped out-of-State to be expanded.

MINERAL FUELS

Coal.—Output of bituminous coal and lignite was 39,000 tons lower than in 1962; total production was 343,000 tons. Seventeen mines (15 underground and 2 strip) in seven counties contributed to the total. Seven mines in Musselshell County produced 63 percent of the bituminous coal production; mines in Blaine, Carbon, and Rosebud Counties also contributed. Most of the lignite came from two mines in Richland County. Montana-Dakota Utilities Co. continued to be the leading consumer of lignite at its Sidney steam electric-generating plant.

Petroleum and Natural Gas.—Recovery of crude oil dropped 773,000 barrels from the record high of 31.6 million barrels in 1962. Petroleum represented about 41 percent of the total value of mineral output in Montana. The Pine, Cabin Creek, and Elk Basin fields yielded 36 percent of the crude oil production. Five other fields—Cut Bank, Lookout Butte, Pennel, Poplar East, and Sumatra—each had production in excess of 1 million barrels. Initial production was reported from five fields—Fred & George Creek, Vida, Spring Lake, Lone Tree, and Goose Lake.

Marketed production of natural gas remained about the same as in 1962, 30.0 billion cubic feet. The Cut Bank-Reagan field continued to be the major source of natural gas; output was 7.2 billion cubic feet. Cedar Creek field ranked second with output of 4.6 billion cubic feet. Five other fields each had output in excess of 1 billion cubic feet—Bowdoin, Cabin Creek, Dry Creek, Keith Block, and Whitlash.

Drilling activity continued at a brisk pace during the year. Discoveries were reported from Sheridan, Richland, Roosevelt, and McCone Counties in the Williston Basin and also from Liberty, Carbon, Wheatland, Glacier, and Toole Counties. There also was activity in the Powder River Basin area, as the result of a Pennsylvanian discovery in Wyoming; however, none of the ventures in the area were successful.

Wildcat wells in the Clark's Fork field (Carbon County) and Vida field (McCone County) yielded both oil and gas. Other new gas wells were discovered in the Mt. Lilly field, Liberty County, about a mile south of a producer in the Flat Coulee field; in an unnamed field in Wheatland County, 4 miles south of Shamut and 17 miles northwest of the nearest production in the Big Coulee field (Golden Valley County); and in an area of Glacier County about a mile west of the Reagan field.

The discovery oil well in Sheridan County was the northernmost producer on the eastern side of the State. Nearest production was 14 miles to the south, and the Outlook field was 26 miles southwest. In Roosevelt County, initial output came from the Shotgun Creek field and from a well in the Tule Creek area. Devonian and Ordovician production was reported from a new well in Richland County, 18 miles northwest of the Brorson field.

The Montana Oil and Gas Conservation Commission approved three new waterflooding projects and expansion of another. The new projects involved areas of the Cut Bank field, Glacier County, and the

Kevin-Sunburst field, Toole County. Expansion of Sun Oil's waterflood project in the Cabin Creek field was expected to result in recovery of an additional 12.4 million barrels of crude oil.

The privilege license tax pertaining to the production of oil and natural gas within the State of Montana was increased, effective July 1, 1963, to the following: (1) $.0025 per barrel for leases producing an average of 25 barrels per day or less; (2) $.005 per barrel for leases producing an excess of 25 barrels per day; (3) 1 mill per 10,000 cubic feet of natural gas.

Work was begun to increase the crude-charge capacity of the Continental Oil Co. Billings plant from 17,000 to 32,000 barrels per day. Refinery products will be moved from Billings to Sinclair, Wyo., via a planned 8-inch, 330-mile pipeline. Estimated cost of the line was $7 million.

Construction began on a 75-mile gathering and transmission system to connect the Flat Coulee, Whitlash, West Whitlash, and Fred and George Creek fields to Cut Bank outlets. Restrictions of operations caused by severe winter weather would be relieved permitting year-round operations. The system was designed for a capacity of 5,000 barrels of crude oil per day.

REVIEW BY COUNTIES

Mineral production for 1963 was reported from 55 of the 56 counties. Silver Bow County accounted for 34 percent of the total mineral-output value. Only counties with significant metal, nonmetal, or fuels developments are discussed in the following review.

Beaverhead.—Thirteen lode mines in the county supplied 938 ounces of gold, 46,668 ounces of silver, 9 tons of copper, 187 tons of lead, and 35 tons of zinc. Six mines in the Argenta district accounted for 64 percent of the metal production value. Lead ore (1,533 tons) from the Maulden mine yielded 92 ounces of gold, 7,244 ounces of silver, 3 tons of copper, 177 tons of lead, and 32 tons of zinc. Gold ore (647 tons) from the Yellowband mine (Shafer group) contained 685 ounces of gold and 862 ounces of silver. Gold ore also was shipped from the Cross, Ermont, Midnight, and Sylvia mines.

The largest silver output in the county was by Spokane National Mines, Inc. The company completed 350 feet of raising and 880 feet of drifting and crosscutting and produced 5 ounces of gold, 16,146 ounces of silver, 1 ton of copper, 2.5 tons of lead, and 1 ton of zinc at the New Departure mine in the Blue Wing district. Operations at the mine were described.[6] Silver ore also was mined at the Charter Oak (Blue Wing district), Hecla (Bryant district), Amazon Copper and Virginia (Dillon district), Comet (Elkhorn district), and Polaris (Polaris district) mines.

In the Argenta district, Phelps Dodge Corp. conducted a geophysical and geochemical exploration program at the Ermont and New Mineral properties. Grand Deposit Mining Co. began exploring the Excelsior property in the Bannack district.

[6] Bogert, John R. Revival for Bannack Gold District. Min. World, v. 25, No. 11, October 1963, pp. 28–29.

TABLE 16.—Value of mineral production in Montana, by counties[1]

(Thousand dollars)

	1962	1963	Minerals produced in 1963, in order of value
Beaverhead	(2)	(2)	Phosphate rock, stone, sand and gravel, silver, talc, lead, gold, zinc, copper.
Big horn	$460	$1,875	Sand and gravel, petroleum, lime, stone, natural gas.
Blaine	429	431	Petroleum, natural gas, sand and gravel, coal, stone.
Broadwater	175	257	Sand and gravel, iron ore, stone, gold, copper, silver, lead, zinc.
Carbon	9,845	8,932	Petroleum, stone, natural gas, sand and gravel, coal, uranium.
Carter	37	1,399	Sand and gravel, stone, petroleum.
Cascade	1,224	680	Sand and gravel, stone, clays, silver, gold, lead, zinc.
Chouteau	----------	724	Stone, sand and gravel.
Custer	144	508	Sand and gravel, stone.
Dawson	4,597	5,962	Petroleum, sand and gravel, stone.
Deer Lodge	783	781	Lime, stone, sand and gravel, silver, copper, gold.
Fallon	17,462	21,380	Petroleum, natural gas, sand and gravel, stone.
Fergus	728	(2)	Gypsum, sand and gravel, clays.
Flathead	370	288	Sand and gravel, stone, silver, copper, gold.
Gallatin	(2)	(2)	Cement, sand and gravel, stone.
Glacier	2,050	2,393	Petroleum, sand and gravel.
Granite	1,505	757	Manganese, silver, sand and gravel, gold, copper, manganiferous ore, stone, lead, zinc.
Hill	50	136	Sand and gravel.
Jefferson	229	(2)	Cement, stone, silver, zinc, lead, gold, copper, clays.
Judith Basin	44	178	Sand and gravel, stone, lead, silver, zinc.
Lake	(2)	210	Stone, sand and gravel, peat.
Lewis and Clark	2,128	3,344	Zinc, stone, sand and gravel, lead, silver, gold, copper.
Liberty	776	1,489	Petroleum, natural gas, lead, copper, silver, zinc.
Lincoln	(2)	(2)	Vermiculite, sand and gravel.
McCone	409	428	Petroleum.
Madison	903	(2)	Talc, sand and gravel, stone, gold, silver, copper, zinc, lead.
Meagher	32	18	Lead, copper, silver, zinc, sand and gravel, gold.
Mineral	65	50	Sand and gravel, stone, copper, silver.
Missoula	465	1,433	Sand and gravel, stone, barite, lime, gold, silver.
Musselshell	4,110	3,322	Petroleum, coal, sand and gravel, stone.
Park	138	609	Stone, sand and gravel, gold, silver.
Phillips	249	246	Natural gas, sand and gravel, stone.
Pondera	69	376	Stone, sand and gravel, petroleum.
Powder River	(2)	97	Stone, sand and gravel, coal.
Powell	(2)	(2)	Phosphate rock, lime, stone, sand and gravel, lead, silver, gold, zinc, copper.
Prairie	(2)	9	Sand and gravel.
Ravalli	597	(2)	Fluorspar, sand and gravel, gold, silver.
Richland	920	1,459	Coal, petroleum, lime, sand and gravel, stone.
Roosevelt	7,254	6,984	Petroleum, sand and gravel.
Rosebud	5,866	4,352	Petroleum, coal.
Sanders	15	140	Sand and gravel, stone, lead, silver, zinc, copper, gold.
Sheridan	3,248	3,355	Petroleum, sand and gravel, stone, coal.
Silver Bow	72,342	61,562	Copper, zinc, silver, lead, gold, sand and gravel, phosphate rock, manganese, stone, manganiferous ore.
Stillwater	(2)	139	Sand and gravel, stone.
Sweet Grass	----------	69	Sand and gravel, stone.
Teton	35	26	Petroleum, sand and gravel.
Toole	1,422	2,163	Petroleum, stone, sand and gravel, natural gas.
Treasure	53	425	Stone, sand and gravel.
Valley	55	281	Stone, sand and gravel.
Wheatland	----------	157	Sand and gravel, stone.
Yellowstone	1,519	3,288	Sand and gravel, stone, petroleum, lime, clays.
Combined counties[3]	21,211	18,642	
Undistributed[4]	26,643	20,673	
Total	190,656	182,027	

[1] No production reported in Daniels County.

[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[3] Petroleum and natural gas production from fields underlying two or more counties. See combined counties section.

[4] Includes value of mineral production that cannot be assigned to specific counties and values indicated by footnote 2.

The Minerals Engineering Co. tungsten mill near Glen was sold at midyear. Tungsten production from the company Calvert pit was stopped in December 1961, and milling operations were terminated early in 1962.

Phosphate rock produced by Victor Chemical Works at its Canyon Creek and Quartz Hill mines was shipped to the company elemental phosphorus plant at Silver Bow. Talc was produced at the Smith-Dillon mine of Tri-State Minerals Co.

Big Horn.—Crude oil was recovered from three fields. Withdrawals of natural gas totaled 48 million cubic feet. Limestone was calcined for use at the Holly Sugar Corp. Hardin plant. Sand and gravel use at the Bureau of Reclamation Yellowtail Dam project totaled 1.2 million tons.

Broadwater.—Ralls & Harris Bros. mined iron ore (magnetite) from two mines in the Cedar Plains district near Radersburg.

Five base- and precious-metal mines yielded gold (29 ounces) and silver (130 ounces) and small amounts of copper, lead, and zinc. Production was from the Silver Saddle (Beaver district), Copper Queen and Keating (Cedar Plains district), and Diamond Hill and Silver King (Park or Indian district) mines.

Ore deposits in the northern part of the Park district were studied.[7]

Carbon.—The county maintained its position of second in the State in value ($8.9 million) of nonmetals and fuels, in spite of decreases in petroleum and natural gas. There was a small increase in coal production. Output of crude oil from the Elk Basin field was 3.3 million barrels, about 400,000 barrels less than in 1962. Most of the 1.9 billion cubic feet of gas came from the Dry Creek field (1.4 billion cubic feet). Two bituminous coal mines yielded production.

Carter.—Sand and gravel production totaled 1.4 million tons as the result of road work by the State highway department. There was a small increase in recovery of crude oil from the Repeat field.

Cascade.—The Lexington mine in the Neihart (Montana) district was operated by Lexington Silver Lead Mining Co., the only active metal producer in the county.

According to The Anaconda Company annual report, production of electrolytic copper at the Great Falls refinery was at the rate of 20.5 million pounds monthly, compared with 22.5 million pounds per month in 1962. The decrease resulted from production curtailment at Butte mines due to the transfer of concentrating facilities from Anaconda to Butte. A new type of copper-melting furnace was installed in the refining department to improve cathode melting and wire-bar casting operations.

Reduced slab zinc production at the electrolytic zinc plant resulted largely from less imports of concentrates from Central- and South-American sources. Operating improvements resulted from constructing a new zinc-concentrate storage area, installing automatic acid control in the leaching operation, utilizing direct leaching of purification residues, and installing casting facilities to produce 2,400-pound and 4,500-pound zinc cakes. Cadmium recovered as a byproduct of processing foreign and domestic zinc concentrates totaled 520 tons.

[7] Schell, Elmer M. Ore Deposits of the Northern Part of Park (Indian Creek) District, Broadwater County, Mont. Montana BuMines and Geol. Bull. 35, June 1963, 47 pp.

American Metal Climax, Inc., continued exploring and developing the Big Ben molybdenum property near Neihart.

There was a sharp drop in sand and gravel output, but the quantity of fire clay mined at the Armington pit for refractory use at the Anaconda Reduction Works in Deer Lodge County was increased over that of the previous year.

Dawson.—Five oilfields yielded 1.7 million barrels of crude oil, slightly less than the 1962 total. The Gas City field continued to be the principal source.

Deer Lodge.—Silver ore was shipped from the Alturas and Silver Reef (Georgetown district), Cameron (Blue-eyed Nellie district), and Mountain Lion (Orofino district) properties. Blunt and Associates conducted a drilling program at the Champion mine, which was leased from The Anaconda Company.

Rehabilitation and transfer of usable milling equipment from the copper concentrator at the Anaconda Reduction Works to the new Butte concentrator continued. Milling copper ore at Anaconda was to be phased out in 1964. A new plant was built at Anaconda to receive Butte copper concentrate. The concentrate, shipped as a slurry in railroad tank cars, was pumped to the roasters, blended with other feed, and conveyed to the reverberatory furnaces. As part of a copper smelter improvement program, modernization of the reverberatory furnace plant was in progress, and a new 100-ton crane was installed in the converter aisle.

The Anaconda Company announced plans for completing a beryllium metal refinery pilot plant at the reduction works in 1964. The plant was to be used in developing methods of refining beryllium oxide concentrates to high-purity metal and to recover beryllium metal from scrap.

Manganese ore from the Govermnent low-grade stockpile was concentrated at the reduction works; however, no manganese nodules were produced. Ferromanganese was not produced; 10,758 tons had been produced in 1962. The company annual report to shareholders indicated that 2,733 tons of arsenic trioxide (white arsenic) was recovered as a byproduct of arsenic-bearing copper ore.

The Extractive Metallurgical Research Division at Anaconda completed plans for a new research laboratory on which construction was to begin in 1964. The Division completed pilot-plant work on an alumina-from-clay process and began designing a commercial plant capable of providing alumina for Anaconda aluminum operations.

There was a slight decrease in the quantity of limestone, from Brown's quarry, calcined for use at The Anaconda Company ore-processing and metallurgical facilities. Refractories were made for the Anaconda operations from Cascade County fire clay.

Fallon.—Crude oil recovery continued to rise; total output was 8.7 million barrels compared with 7.1 million in 1962. The Cabin Creek field accounted for 3.5 million barrels. Both the Pennel and Lookout Butte fields had more than 2.0 million barrels of production. Three gasfields yielded 5.8 billion cubic feet of natural gas. Cedar Creek field, the second most important source in the State, furnished 4.6 billion cubic feet; over 1 billion cubic feet came from the Cabin Creek field.

Fergus.—Vitro Minerals Corp. acquired property options and began exploring claims in the Gilt Edge, Whiskey Gulch, and Spotted Horse areas.

There was a substantial increase in the tonnage of gypsum mined near Heath by United States Gypsum Co. and near Hanover by Ideal Cement Co. Less clay and sand and gravel were produced than in the previous year.

Flathead.—Silver ore was mined at the Flathead and Ole properties in the Hog Heaven mining district.

The 67,354 tons of aluminum produced at the Anaconda Aluminum Co. reduction plant represented the largest output since operations began in 1955. The reduction plant consumed 1.26 billion kilowatt-hour of electric energy (1.7 percent more than in 1962), costing $2.1 million (1.66 mills per kilowatt-hour).

Gallatin.—Output value of nonmetal commodities increased moderately compared with 1962. The Trident plant of Ideal Cement Co. continued to be the leading mineral industry in the county. By virtue of road work by the State highway department, the county was the second ranking source of sand and gravel.

Glacier.—Crude oil output increased to 942,000 barrels from 794,000 barrels in 1962. Five fields contributed to the production.

Granite.—Value of base- and precious-metal production declined nearly $750,000, compared with 1962 totals, largely due to sharply reduced output from mines in the Flint Creek (Philipsburg) district. Silver ore was shipped from eight mines in the Flint Creek district—Algonquin, Bi-Metallic, Cudgie Taylor, Hobo, Comanche Extension, IB, Mountain Boy, and New Seattle-Dolly Quartz. Except for a small leasing operation at the Algonquin mine, the Algonquin (Trout Mining Co.) and True Fissure (Taylor-Knapp Co.) properties, the two largest operations in the county in 1962, were idle.

In the Henderson district, John C. Bork & Sons produced 159 ounces of gold, 50,056 ounces of silver, and 32 tons of copper from the Black Pine mine. Silver ore was extracted at the Harper mine, and gold-silver tailings were shipped from the Rumsey mine. Gold ore came from the Mickey mine in the Red Lion district.

Taylor-Knapp Co. continued to produce manganese ore, but production was at a lower rate than in 1962.

Jefferson.—The value of metal production rose to $175,374, and production was from 14 properties. The leading gold output was from ore and old tailings from the Basin Jib property, Cataract (Basin) district. The largest silver and copper production came from the Hope mine in the Whitehall district, and Lahey Leasing Co. (Alta-Custer mine) was the leading lead and zinc producer. Gold and silver ores also were shipped from the Boulder, Comet, Crystal, Golden Thread, Hildebrant, Hope & Bullion, Mount Thompson, and Silver Hill mines in the Cataract district and the Lucky Hit and Silver Queen properties in the Whitehall district.

United Buffadison Mines, Ltd., began exploring 13 claims in the Crystal mine area and announced plans for a drilling program in 1964. Cement production began at the Montana City plant of Permanente Cement Co. The 1.4-million-barrel-capacity plant provided cement for construction of the Yellowtail Dam on the Big Horn River.

Judith Basin.—The Tiger mine, Barker district, yielded 48 tons of ore containing 239 ounces of silver and 12 tons of lead. A small quantity of lead ore was extracted at the Liberty mine.

Lewis and Clark.—Lead and zinc production from The Anaconda Company slag-fuming plant at East Helena was responsible for 98.5 percent of the value of metal output in the county. Production from old smelter slag at the fuming operation was 1,328 tons of lead and 8,597 tons of zinc, an increase over the 969 tons of lead and 7,008 tons of zinc recovered in 1962. The rise in fume output resulted from increased demand for zinc-bearing raw materials at the Great Falls electrolytic zinc plant.

Twelve other operations in seven mining districts recorded production. The largest output was from the Empire mine (lead ore) in the Marysville district and from the Peck mill (gold tailings) in the Helena district. Lead ore was extracted at the Nick & Dick mine, Canyon Ferry district; Mike Horse mine, Heddleston district; and Franklin & Sam Gaty mine, Ten Mile district. Most gold and silver mining operations produced only minor amounts of metal.

Liberty.—The only metal production was from the East Butte mine in the Sweetgrass Hills district; 37 tons of ore yielded 194 ounces of silver, 1 ton of copper, and 4 tons of lead.

Recovery of crude oil from four fields in the county was 468,000 barrels, 238,000 barrels higher than in 1962. Natural gas withdrawals increased to 5.7 billion cubic feet from 3.8 billion cubic feet in the previous year. Principal gasfields were Keith Block (2.4 billion cubic feet) and Whitlash (2.3 billion cubic feet).

Madison.—Value of metal production continued to decline; output was from nine mines. Pacific Mines, Inc., accounted for over one-half of the production value by producing 437 ounces of gold, 12,560 ounces of silver, and 1 ton of copper from the Pacific mine in the Virginia City district. The leading copper producer was Woodfold Corp. from the Dictator & Bell Union mine in the Sheridan district. Other major production was from gold mining operations at the Red Pine and Tamarack properties, Sheridan district.

Talc was mined by three companies at four operations—Sierra Talc Co. (Yellowstone mine), Tri-State Minerals Co. (Treasure State mine), and American Chemet Corp. (Madison and Rebish & Ike mines).

McCone.—Recovery of crude oil from the Richey-Southwest and the new Vida fields was 180,000 barrels, a 14,000-barrel increase over the 1962 total.

Meagher.—Hoco, Inc., accounted for most of the value of metal production from its lead ore operation at the Cumberland mine in the Castle Mountain district. The Copper Duke and Copperopolis mines in the Musselshell district yielded copper ore.

Mineral.—Ten tons of copper ore from the Spitfire mine, site of the only metal-mining operation in the county, yielded 7 ounces of silver and 1,300 pounds of copper.

The Bunker Hill Co. continued exploring and developing the Nancy Lee mine in the Keystone district near Superior. A substantial amount of drifting, crosscutting, and raising was completed; however, the company reported that only a small amount of ore, located

between the 790 and 940 levels, was developed. Some development ore was stockpiled in preparation for the resumption of milling operations.

McIsaac Mining Co. completed an agreement with Mineral King Mining Co. to unwater the Tarbox mine near Saltese and conduct an exploration program at the property. The mine and the 1,000-foot shaft had been flooded since 1918.

Missoula.—Barite was mined by Baroid Sales Division, National Lead Co. near Greenough. American Crystal Sugar Co. calcined limestone to lime for use at its sugar refinery.

Musselshell.—Recovery of crude oil from eight fields was 1.2 million barrels. The Ivanhoe, Keg Coulee, and Big Wall fields furnished most of the output. Bituminous coal was produced at seven mines; output (33,800 tons) was 24,000 tons less than in 1962.

Park.—Como Mining Co., the only metal producer, extracted 151 tons of gold ore from the Glengarry mine in the New World district.

Phillips.—At the Little Ben property, Northern Continental, Inc., completed a long drift to explore the downward extension of ore shoots mined on higher levels and completed other exploration.

Powell.—The Negros mine in the Nigger Hill district yielded 83 tons of ore with a recoverable metal content of 6 ounces of gold, 959 ounces of silver, 12 tons of lead, and 1 ton of zinc. Lead ore also was mined at the Sunrise property, Nigger Hill district.

Phosphate rock production was substantially higher than in 1962; Montana Phosphate Products Co. and George Relyea furnished the output. Most of the rock was exported to the Consolidated Mining & Smelting Company of Canada, Ltd., plant at Trail, British Columbia, for use in making phosphate fertilizers. Elliston Lime Co. marketed quicklime and hydrated lime.

Ravalli.—A small quantity of gold ore came from the Larrigon mine (Larrigon Mining Co.), Hughes Creek district. Larrigon Mining Co. was awarded a $31,610 OME contract; Government participation was to be $15,805. Hughes Creek Dredging Co. produced gold at a dragline dredge operation on Hughes Creek in the Overwich district, but output was sharply below the 1962 total.

Richland.—The tonnage of lignite produced by Knife River Coal Mining Co. at Sidney declined slightly. Crude oil output was 205,000 barrels; Spring Lake, a new producer, yielded 137,000 barrels of the total. Limestone was calcined to lime by Holly Sugar Corp. for use at its refinery.

Roosevelt.—Crude-oil production from six fields was 2.6 million barrels, 200,000 barrels less than in the previous year. Poplar-East, with output of 1.6 million barrels, was the leading producing field in the county.

Rosebud.—Recovery of crude oil dropped to 1.7 million barrels from 2.4 million in 1962. Most of the decline resulted from smaller output from the Sumatra field.

Sanders.—Two metal mines were operated—lessees of the Jack Waite mine produced sizeable quantities of lead and zinc, and 200 tons of ore from the Raven mine yielded 1,684 ounces of silver and 3 tons of copper.

Coeur d'Alene Silver Mountain Mining Co. began a 700-foot-long adit at the Eddy Creek property to intersect the downward projection of the Bay Chief vein. The property was leased from Montana-Coeur d'Alene Mines, Inc.

A study of mines and mineral deposits in the county was published by the Montana Bureau of Mines and Geology.[8]

Sheridan.—Crude oil production from six fields totaled 1.3 million barrels (1.4 million barrels in 1962). Two new fields—Lone Tree and Goose Lake—began production.

Silver Bow.—Production of gold, silver, copper, lead, and zinc by The Anaconda Company furnished 95 percent of the value of precious- and base-metal output in the State.

For the 3d consecutive year, no manganese ore was mined in the county; however, purchased Government low-grade stockpile material was shipped to Anaconda, Deer Lodge County, for processing.

Copper ore shipped via the Butte, Anaconda & Pacific Railway Co. diminished as the new copper concentrator at Butte increased production.

Summit Valley (Butte) District.—Output was largely from five mines of The Anaconda Company. Production from the Badger State and other zinc operations was 1,206,614 tons of ore, 2,627 ounces of gold, 1,471,934 ounces of silver, 1,563 tons of copper, 3,185 tons of lead, and 24,140 tons of zinc. The 6,948,375 tons of copper ore from the Berkeley pit yielded 9,115 ounces of gold, 785,095 ounces of silver, and 35,581 tons of copper. The Butte Hill mines (Mountain Con, Steward, and Leonard) accounted for 1,190,805 tons of ore, 2,528 ounces of gold, 1,692,208 ounces of silver, and 41,139 tons of copper. Copper is being recovered from mine water at Butte using a series of tanks for settling the slurry with scrap iron as an attractor.[9]

Anaconda continued to emphasize a development program designed to tap high-grade ore reserves at depth and to improve haulage and hoisting facilities. The Kelley No. 1 shaft was deepened 530 feet to a depth of 4,724 feet; upon completion to a depth of 4,852 feet, the shaft was to be used for centralized hoisting of copper ores from the deep levels of the Mountain Con, Steward, and Leonard mines. The Kelley No. 2 shaft was completed to the 3000 level, but further work to prepare it for use as a central pumping shaft was postponed until sinking of the Kelley No. 1 shaft was completed. The Steward subshaft was completed and placed in operation early in the year. The Neversweat ventilation shaft was sunk 500 feet to the 2800 level, and sinking was to continue to the 4500 level.

As a result of increased ventilation problems brought on by deeper mining operations, a new surface refrigeration plant was installed at the Mountain Con mine to augment an existing cooling system.[10]

The Anaconda Company announced that copper ore reserves at Butte were greater than the 310 million tons mined in the district in the previous 83 years. A major portion of these reserves was expected to be mined by open-pit methods.

---

[8] Crowley, F. A. Mines and Mineral Deposits (Except Fuels), Sanders County, Mont. Montana BuMines and Geol. Bull. 34, May 1963, 58 pp.

[9] The Northwest. Anaconda Takes Copper Out of Water From Butte Mines. November–December, 1963, pp. 10–11.

[10] O'Leary, V. D. Recent Developments Underground at Butte. Min. Eng., v. 15, No. 11, November 1963, pp. 39–42.

TABLE 17.—Production of gold, silver, copper, lead, and zinc in Silver Bow County in terms of recoverable metals, 1882–1963

Year	Material treated, short tons	Gold (troy ounces)	Silver (troy ounces)	Copper (tons)	Lead (tons)	Zinc (tons)	Total value
1882–1903	[1]	847,193	171,826,169	1,669,609	517	----------	$591,616,666
1904	4,102,604	46,974	10,530,582	145,066	----------	----------	44,200,503
1905	4,419,300	61,251	11,191,016	152,154	570	780	55,643,230
1906	5,019,234	60,496	10,715,721	144,890	448	3,290	64,810,013
1907	3,735,346	34,368	7,516,659	109,418	112	122	49,464,959
1908	3,858,058	32,006	8,500,729	125,075	299	820	38,289,087
1909	5,000,062	39,443	10,609,328	155,662	100	4,650	47,315,005
1910	4,709,429	37,014	10,400,840	142,132	175	15,810	44,206,144
1911	4,569,942	35,406	10,258,122	136,136	508	21,867	42,741,229
1912	5,243,935	38,441	11,352,106	154,111	648	13,396	60,539,927
1913	5,612,530	37,720	12,211,725	142,841	2,271	44,265	57,593,753
1914	4,749,189	31,791	10,511,032	116,094	2,693	54,771	43,147,603
1915	5,574,105	39,151	12,484,609	133,003	3,968	93,257	77,190,924
1916	7,209,835	47,071	14,983,771	174,769	4,598	112,293	127,547,714
1917	5,681,058	33,418	11,511,600	135,296	5,176	90,158	103,330,806
1918	7,394,038	43,639	15,013,855	160,554	11,373	102,482	115,496,193
1919	3,907,089	28,040	10,531,127	84,526	10,156	83,647	57,107,312
1920	5,013,847	31,299	10,575,894	88,202	8,795	91,906	60,929,101
1921	1,141,013	13,714	4,983,972	23,979	6,621	11,451	13,194,969
1922	4,010,759	26,304	10,395,880	82,687	10,070	58,971	41,095,544
1923	5,261,344	30,359	11,837,475	111,522	12,751	70,506	54,495,627
1924	4,192,371	35,391	11,859,370	123,682	13,649	63,918	51,575,310
1925	3,862,401	36,192	11,568,302	133,318	12,091	56,890	57,390,128
1926	3,985,585	32,877	11,060,900	126,495	13,678	71,653	55,936,816
1927	3,753,246	26,313	9,659,142	110,656	12,769	78,314	46,645,518
1928	3,896,048	28,869	9,558,619	123,533	12,330	73,948	52,218,170
1929	4,271,213	26,059	9,918,906	148,158	8,239	50,550	65,687,913
1930	2,351,836	12,974	5,257,545	97,736	2,540	13,984	29,300,169
1931	1,869,348	10,010	3,698,742	92,181	----------	----------	18,056,499
1932	652,967	4,183	1,563,752	42,304	1	----------	5,857,814
1933	613,752	4,465	2,361,320	32,620	4,185	15,481	6,726,018
1934	644,487	3,861	2,826,252	31,428	5,391	21,165	9,209,595
1935	1,611,448	9,040	6,547,794	76,964	10,302	37,646	21,935,776
1936	2,796,273	15,183	7,990,124	109,004	10,527	34,940	31,238,996
1937	3,684,972	20,521	8,071,519	143,879	5,780	22,033	45,326,482
1938	1,642,491	15,147	4,018,192	76,855	207	942	18,300,823
1939	2,498,922	22,036	6,114,455	97,267	4,708	20,016	27,677,359
1940	3,764,610	25,107	8,766,398	125,442	8,859	35,899	40,871,719
1941	4,421,641	29,485	8,993,693	127,432	8,630	38,070	44,195,725
1942	4,753,741	22,381	8,123,788	140,349	7,206	29,313	46,942,464
1943	5,163,966	16,132	6,487,380	133,569	3,290	7,877	42,100,656
1944	5,429,931	15,463	6,001,695	117,366	3,348	8,087	38,877,303
1945	4,528,282	12,484	4,976,910	87,950	2,926	8,493	30,179,133
1946	1,827,606	6,926	2,417,969	57,905	2,357	7,108	23,205,317
1947	2,624,915	19,801	5,252,011	57,187	10,635	40,713	42,379,878
1948	2,637,479	19,163	6,100,232	57,712	13,224	52,625	49,971,332
1949	2,297,584	15,757	5,636,112	55,945	11,490	47,982	43,225,091
1950	3,387,270	23,163	6,123,549	53,897	15,679	63,510	51,044,252
1951	3,780,943	15,674	5,950,647	56,826	16,630	80,500	68,493,990
1952	4,425,605	16,930	5,518,197	61,559	16,162	75,968	65,806,893
1953	5,998,457	19,871	6,289,415	77,520	16,767	75,170	72,566,257
1954	4,987,849	17,395	4,663,439	59,240	11,516	53,527	54,498,289
1955	7,159,693	22,262	5,577,999	81,428	14,331	62,588	86,240,115
1956	9,394,981	31,132	6,772,380	96,292	14,989	63,375	111,138,462
1957	10,673,175	27,312	5,068,834	91,393	9,617	43,169	73,327,727
1958	10,745,428	17,374	3,307,748	90,557	5,492	26,580	57,942,199
1959	8,679,400	18,615	3,204,038	65,810	4,456	22,459	50,149,131
1960	12,168,767	21,819	2,918,104	91,754	1,889	4,755	63,979,580
1961	12,635,383	18,391	2,765,478	103,788	435	1,384	65,881,072
1962	11,654,394	17,657	4,026,697	93,845	4,319	28,636	70,176,106
1963	9,346,244	14,287	3,951,004	79,636	3,185	24,140	60,849,789
1882–1963 Total	[2] 291,027,421	2,362,800	628,910,863	7,818,208	405,678	2,337,850	3,687,082,175

[1] Data not available.
[2] Material treated 1904–63.

At yearend, construction of the 42,000-ton-per-day Butte concentrator, the fourth largest domestic copper mill and the first to employ autogenous grinding on a large scale, was nearly completed. The concentrating and auxiliary facilities included 14 buildings, ore storage bins, a tailings disposal area with facilities for water reclamation, underground and overhead conveyor systems, 12 autogenous crushers and 12 grinding mills, flotation cells, 8 thicknesses, a water pipeline from the Anaconda Reduction Works, a 10-million gallon water reservoir, and a new railroad line. The plant was designed for possible expansion to 56,000 tons per day should increased output become warranted. When operating at capacity, about 15 million gallons of fresh water and 30 million gallons of reclaimed water per day were expected to be used.

Concentrate from the Butte mill, containing 28 to 30 percent copper, was shipped in tank cars to the Anaconda Reduction Works via the Butte, Anaconda & Pacific Railroad. Each car carried 100 tons of concentrate slurry containing 70 percent solids. On the return trip to Butte, milk of lime used in the flotation process was hauled from the company lime plant at the reduction works.

Phosphate rock production at the Maiden Rock mine (Victor Chemical Works) was lower than in 1962. Output was converted to elemental phosphorus at the company Silver Bow plant.

Stillwater.—American Chrome Co. dropped its lease on the Mouat mine but continued efforts to obtain a contract to upgrade the Government chromite concentrate stockpiled at Nye. Monte-Vista Corp. of Billings obtained the lease vacated by American Chrome and announced plans to build a $5-million chromic-acid plant.

Toole.—Production of crude oil and natural gas was 685,000 barrels and 1.1 billion cubic feet, respectively. The Kevin-Sunburst field was the major source of both the oil and gas.

Yellowstone.—Crude oil production from the Mosser and Wolf Springs fields continued to decline; output was 202,000 barrels, 73,000 barrels less than in 1962. Elemental sulfur was recovered from waste gases originating at the Continental Oil Co. and Humble Oil & Refining Co. refineries.

The county ranked first as a source of sand and gravel and second for stone production. Clay and shale were used, respectively, to make heavy clay products and lightweight aggregate. Limestone was calcined to lime by the Great Western Sugar Co. for use at its Billings refinery.

Combined Counties.—The following counties have been combined into areas as indicated because a major oilfield or gasfield underlies parts of more than one county, and its production cannot be assigned to a single county:

Dawson, Fallon, McCone, Prairie, and Wibaux.—The Pine field, the largest producer in the State, yielded 4.3 million barrels of crude oil, 463,000 barrels less than in 1962. The same field produced 699 million cubic feet of gas compared with 759 million cubic feet in the previous year.

Garfield and Petroleum.—The Cat Creek field crude oil output was 234,000 barrels, an increase of 14,000 barrels over 1962.

Glacier and Toole.—Recovery of crude oil from the Cut Bank field was 1.8 million barrels, about 100,000 barrels less than the 1962 figure. Natural gas withdrawals from the Cut Bank-Reagan field, the leading gas source in the State, were 7.2 billion cubic feet compared with 8.6 billion cubic feet in the previous year. Output from this field has decreased 5.2 billion cubic feet compared with production in 1961.

Golden Valley and Stillwater.—Withdrawals of natural gas from the Big Coulee field totaled 958 million cubic feet, a 6 million cubic-foot increase over the 1962 yield.

Musselshell and Rosebud.—The Stensvad and Bascom fields had a combined output of 566,000 barrels of crude oil; production in 1962 was 901,000 barrels. Output from the Stensvad field has dropped 991,000 barrels compared with 1961.

Pondera and Teton.—The Pondera, Conrad-South, and Pondera Coulee fields yielded 437,000 barrels of crude oil. Production in 1962 was 467,000 barrels.

The Mineral Industry of Nebraska

By Carl L. Bieniewski [1]

MINERAL production in Nebraska was valued at $98.7 million, $9.7 million, or 9 percent, less than the record $108.4 million of 1962. For the first time in 16 years, the value of mineral production did not increase. A substantial decrease of $8.8 million in value of petroleum production was the main reason for the decline. Petroleum output was valued at $61.6 million, or 62 percent of the total value of mineral production.

Mineral fuels accounted for 67 percent of the State total value of mineral production compared with 69 percent in 1962. Production of all the mineral fuels—natural gas, natural gas liquids, and petroleum—decreased. Of the nonmetals group, clays and lime increased in production; cement output decreased. Stone increased in quantity but decreased in value of output; conversely, sand and gravel increased in value but decreased in quantity. The value of gem stones remained the same as in 1962. No metals were produced.

TABLE 1.—Mineral production in Nebraska [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	142	$142	148	$148
Gem stones	(2)	5	(2)	5
Natural gas—million cubic feet	14,880	2,708	13,051	2,454
Natural gas liquids:				
LP gases—thousand gallons	28,718	1,329	25,931	1,207
Natural gasoline and cycle products—do	12,239	809	10,119	687
Petroleum (crude)—thousand 42-gallon barrels	24,894	70,450	[3] 21,775	[3] 61,623
Sand and gravel—thousand short tons	12,853	9,797	11,166	10,680
Stone—do	3,670	6,626	3,700	6,192
Value of items that cannot be disclosed: Cement, lime, and pumice		16,507		15,710
Total		[4] 108,373		98,706

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Preliminary figure.
[4] Revised figure.

Seventy-seven of the 93 counties reported mineral production. Kimball, the county leading in output value, accounted for one-fifth of the State total value of mineral production.

[1] Mining engineer, Bureau of Mines, Denver, Colo.

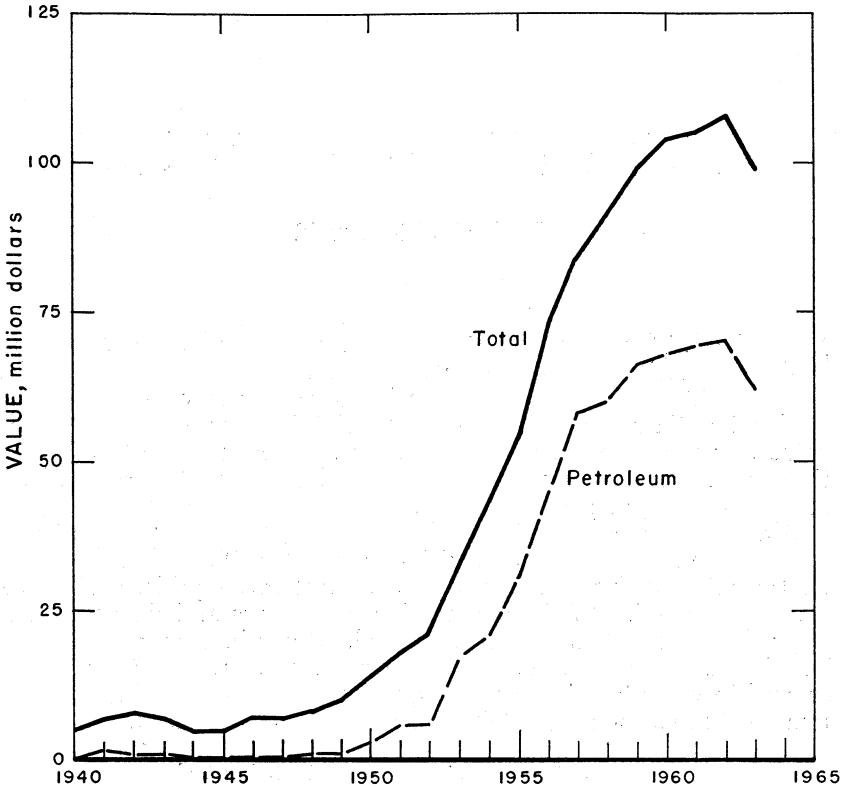


FIGURE 1.—Value of petroleum, and total value of mineral production in Nebraska, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$23,668	1958	$90,156
1953	36,539	1959	99,621
1954	45,366	1960	103,733
1955	58,111	1961	104,543
1956	75,088	1962	106,484
1957	82,582	1963	97,347

Government Programs.—Nebraska's share of mineral payments of bonuses, royalties, and rentals from mineral leasing on Federal lands within its boundary was $7,044, or 37.5 percent of total payments collected by the Federal Government. The State received $384,847 in bonuses, rentals, and royalties from mineral leasing on State-owned lands.

Government construction projects, especially road building, consumed much of the output of cement, stone, and sand and gravel. State highway construction contracts awarded during the year totaled $42.4 million [2] plus $2.3 million for construction of missile-site roads. Highlighting the road work done during the year was the completion of 79 miles of new roads in the National System of Interstate and Defense Highways. At yearend, 168 miles [3] of roads was open to traffic, and the balance of the 490 miles designated in this system for Nebraska was either under construction or in the engineering and right-of-way phase.

Construction of the Ainsworth-and-Farwell unit projects of the Federal Bureau of Reclamation and missile-site preparation by the U.S. Army Corps of Engineers also consumed large quantities of cement and sand and gravel. Bank stabilization projects of the Corps of Engineers for the Platte and Missouri Rivers required a substantial part of the stone output.

The Hallam Nuclear Power Facility started to feed steam into the turbine-generator in May and by mid-July had reached the designated output of 75,000 kilowatts. Transfer of the plant by Atomics International, a division of North American Aviation, Inc., the designer-builder, to Consumers Public Power District of Nebraska, the designated operator, was scheduled for early 1964. Owned by the U.S. Atomic Energy Commission (AEC), the nuclear portion of the plant was a sodium-cooled graphite-moderated reactor, one of four in the Nation. The agreement between the AEC and Consumers was modified so that the first replacement core of the reactor would be uranium carbide instead of uranium oxide.

Water.—The Federal Bureau of Mines conducted a nationwide survey of water used in the mineral industries during 1962. Table 3 summarizes the results of the survey for Nebraska. Table 4 shows in detail by counties the water used in drilling oil and natural gas wells.

---

[2] Engineering News-Record. State Highway Contracts Will Rise. V. 172, No. 13, Mar. 26, 1964, pp. 13–15.

[3] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1963. Press Release BPR 64–9, Feb. 7, 1964.

TABLE 3.—Water used during 1962 in the mineral industry, by type of operations

(Million gallons)

Type of operation [1]	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	120	70	190	113	7	18.01
Sand and gravel operations	1,597	1,258	2,855	1,437	160	233.34
Natural gas processing plants	121	5,172	5,293	31	90	56.67
Total	1,838	6,500	8,338	1,581	257	
Oil and natural gas well drilling			143			
Secondary-recovery operations			1,975			
Total			2,118			
Grand total			10,456			

[1] Water survey did not include cement plants, lime plants, metal smelters, metal refineries, petroleum refineries, natural-brine operations, sand and gravel operations using suction dredges without preparation plants, stockpile operations, and assessment work operations.

TABLE 4.—Water used during 1962 for oil and natural gas wells drilled, by counties

County	Number of wells	Total footage drilled (feet)	Fresh water used	Saline water used	Total water used	Total barrels per foot
			(42-gallon barrels)			
Arthur	3	14,857	13,074		13,074	0.88
Banner	105	635,415	679,894		679,894	1.07
Box Butte	5	23,311	20,514		20,514	.88
Buffalo	4	15,672	13,791		13,791	.88
Chase	2	8,102	7,130		7,130	.88
Cherry	1	4,337	3,817		3,817	.88
Cheyenne	67	341,371	382,336		382,336	1.12
Custer	15	56,025	49,302		49,302	.88
Dawson	9	32,623	28,708		28,708	.88
Deuel	2	7,511	11,500		11,500	1.53
Dundy	2	9,093	8,002		8,002	.88
Franklin	2	8,321	7,322		7,322	.88
Frontier	19	72,870	100,561		100,561	1.38
Furnas	12	43,069	46,515		46,515	1.08
Garden	5	17,746	22,360		22,360	1.26
Garfield	4	12,550	11,044		11,044	.88
Gosper	5	19,330	17,010		17,010	.88
Grant	1	5,220	4,594		4,594	.88
Harlan	6	22,095	19,444		19,444	.88
Hayes	12	55,190	48,567		48,567	.88
Hitchcock	14	61,751	54,341		54,341	.88
Holt	5	2,500	2,200		2,200	.88
Keith	7	33,151	29,173		29,173	.88
Kimball	114	719,827	568,662		568,662	.80
Lincoln	44	170,712	266,311		266,311	1.56
Logan	5	19,861	17,478		17,478	.88
Loup	6	9,500	8,360		8,360	.88
McPherson	11	48,096	42,324		42,324	.88
Morrill	42	202,678	253,348		253,348	1.25
Perkins	7	35,021	30,818		30,818	.88
Phelps	2	8,599	7,567		7,567	.88
Red Willow	131	474,298	498,399	18,586	516,985	1.09
Rock	6	28,356	24,953		24,953	.88
Saunders	2	3,955	6,000		6,000	1.52
Scotts Bluff	10	53,421	49,682		49,682	.93
Sheridan	3	9,477	11,846		11,846	1.25
Sioux	2	8,603	7,571		7,571	.88
Thomas	1	3,901	3,433		3,433	.88
Total	693	3,298,415	3,377,951	18,586	3,396,537	[1] 1.03

[1] Average.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Natural Gas.—Output of marketable natural gas, which consisted of 61 percent dry natural gas from gas wells and 39 percent casing head gas from oil wells, was 1.8 billion cubic feet, or about 12 percent, below that of 1962. Cheyenne County accounted for 82 percent of the total output; Deuel County, 15 percent; and Kimball County, 3 percent. The average values of dry natural gas and casing head gas at the wells were $0.163 and $0.126 per thousand cubic feet, respectively.

Natural Gas Liquids.—Production of LP gases (butane and propane) was 2.8 million gallons, or 10 percent, below that of 1962. Production of natural gasoline and cycle products decreased 2.1 million gallons, or 17 percent. These natural gas liquids were recovered at two natural gasoline plants in Cheyenne County and at one each in Banner, Deuel, and Kimball Counties. The daily throughput of the five plants averaged 58 million cubic feet of natural gas, three-fourths of the total capacity of the plants.

Petroleum.—The growth record of petroleum production over the past 15 years was broken; output fell about 3 million barrels, or 13 percent, below that of 1962. Increased production in some established oilfields and production from newly discovered oilfields were not enough to offset the decreases in other established oilfields. Of 318 oilfields active during the year the Sleepy Hollow oilfield had the most production, 3.2 million barrels, compared with 5.8 million barrels in 1962. The Singleton field in Banner County and the Sloss field in Kimball County had production exceeding 1 million barrels. Production from the Singleton field increased slightly more than 500,000 barrels; whereas that of the Sloss dropped about 380,000 barrels. Forty-eight fields each produced between 100,000 and 1 million barrels; two of these fields were 1963 discoveries.

Drilling declined for the 2d consecutive year; 523 wells were completed, compared with 691 in 1962. All wells were drilled by rotary rigs. The number of rigs drilling at one time ranged from 8 to 18. The average depth of the wells completed was 5,041 feet. Discovery of the Canal field in 1962 spurred drilling activity in Scotts Bluff County. With 45 wildcat wells drilled, Scotts Bluff County led the other counties in exploratory drilling for the first time. Of three new fields discovered in the county by the wildcat drilling, one, the Cedar Valley field, was probably the most significant discovery in the State. By yearend, 16 wells in the Cedar Valley field had pumped nearly 350,000 barrels, which made it the 11th most productive field in the State for the year. Another important discovery was the Northwest Sleepy Hollow field near the Sleepy Hollow field in Red Willow County. Initial production from this field was 350 barrels of oil per day.

The Cooperative Refinery Association oil refinery at Scottsbluff processed crude petroleum from oilfields in southeastern Wyoming.

747-416—64——44

TABLE 5.—Crude petroleum production, by counties [1]

(Thousand barrels)

County	1962	1963 [2]	Principal fields in 1963 in order of production
Banner	4,777	5,060	Singleton, Kenmac, Willson Ranch, Barrett, Vowers.
Cheyenne	3,690	3,243	Reimers, Juelfs Gaylord, Doran Farms, Cook, Preble, North Faro.
Dundy	26	18	Indian Creek, Pierce Lake, Highland, Rock Canyon.
Frontier	3	(3)	Spring Creek.
Furnas	3	2	Beaver Creek.
Garden	10	8	Richards, McCord.
Harlan	82	57	South Alma.
Hayes	7	9	Blackwood Creek.
Hitchcock	193	214	Reiher, Dry Creek.
Kimball	7,712	6,769	Sloss, Griffith, Enders, Travis, Kimball, Bean, Heidmann, Southwest Potter.
Lincoln	11	13	Red Willow Creek.
Morrill	1,247	1,344	Olsen, Waitman, Lindberg.
Red Willow	6,973	4,363	Sleepy Hollow, Silver Creek, Ackman.
Richardson	127	91	Dawson, Falls City, Barada.
Scotts Bluff	33	584	Cedar Valley, Canal, Vessels.
Total	24,894	21,775	

[1] Based on 1963 Nebraska Drilling and Oil Production Summary, Conservation and Survey Division University of Nebraska; data adjusted to Bureau of Mines total.
[2] Preliminary figures.
[3] Less than 1,000 barrels.

TABLE 6.—Wildcat and development well completions in 1963, by counties

County	Oil	Gas	Dry	Total	Footage
Wildcat:					
Arthur			1	1	5,000
Banner	3		19	22	114,200
Buffalo			1	1	3,700
Chase			1	1	5,500
Cheyenne	5		34	39	198,300
Dawes			9	9	42,300
Deuel			7	7	25,900
Frontier			3	3	12,200
Furnas			5	5	17,800
Garden			2	2	11,100
Grant			3	3	13,700
Harlan			1	1	3,700
Hayes			8	8	37,600
Hitchcock	1		9	10	45,800
Hooker			2	2	8,700
Keith			5	5	24,000
Kimball	4		32	36	243,400
Lincoln			11	11	49,900
Morrill			17	17	76,000
McPherson			2	2	8,700
Red Willow	7		23	30	108,700
Richardson			1	1	1,500
Scotts Bluff	3		42	45	251,300
Sheridan			4	4	17,700
Sioux			6	6	33,100
Total	23		248	271	1,359,800
Development:					
Banner	14		23	[1] 38	233,200
Cheyenne	10	1	20	31	156,300
Furnas			1	1	3,400
Harlan	2		2	4	14,700
Hayes			1	1	4,900
Hitchcock	11		2	13	56,800
Kimball	21		34	[1] 56	351,100
Morrill	6		6	12	56,600
Red Willow	45		18	[1] 64	227,000
Scotts Bluff	21		11	32	172,500
Total	130	1	118	[2] 252	1,276,500
Total all drilling	153	1	366	[2] 523	2,636,300

[1] Includes 1 service well.
[2] Includes 3 service wells.

Source: Oil and Gas Journal.

NONMETALS

Cement.—Portland and masonry cements were produced by Ash Grove Lime & Portland Cement Co. in Louisville and by Ideal Cement Co. in Superior. The plants were operated at about 94 percent annual capacity. Shipments from the plants were slightly below those of 1962. Eighty-three percent of the shipments were consumed within the State; the balance was sent to nearby States. Portland cement constituted 98 percent of the shipments and masonry cement 2 percent. Ready-mixed concrete companies purchased 54 percent of the portland cement shipments, and highway contractors purchased 25 percent. Other portland cement buyers were building-material dealers, concrete-product manufacturers, Government agencies, and building contractors other than highway contractors.

Clays.—Five companies produced the clay output of 148,000 tons from surface operations, 6,000 tons, or 4 percent, more than in 1962. Four of the companies used clay to make building bricks, and the other company used clay for producing cement.

Lime.—Greater sugar production than that of 1962 resulted in a 73-percent increase in lime output. The total output of lime was produced and used at five sugar plants—four of The Great Western Sugar Co. and one of American Crystal Sugar Co. The lime, in the form of quicklime, was used in extracting sugar from sugar beets.

Perlite.—Western Mineral Products Co. processed crude perlite shipped from deposits in Nevada and New Mexico at its Omaha plant. The expanded perlite was used in building plaster and as a concrete aggregate.

Pumice.—LaRue Axtell Pumice Co. mined crude pumice at the LeMaster mine in Lincoln County. After processing at the company plant at Callaway in Custer County, the pumice was sold for use as a cleansing compound and as an abrasive.

Sand and Gravel.—Production of sand and gravel decreased 1.7 million tons, and was 13 percent below that of 1962. Paving, including road construction, road-bridge construction, and road maintenance, required 6.9 million tons, or 62 percent of the total output; building construction required 3.6 million tons, or 32 percent; and railroad ballast, fill, and other uses required 0.7 million tons, or 6 percent. The total output of 11.2 million tons was produced at 239 operations, 202 commercial and 37 Government-and-contractor. Output from commercial operations was 9.9 million tons, or 89 percent of the total output; that from the Government-and-contractor operations was 1.3 million tons, or 11 percent. Commercial producers, in order of output greater than 200,000 tons, were Lyman-Richey Sand & Gravel Corp., Central Sand & Gravel, Luther & Maddox Gravel Co., Lincoln Sand & Gravel Co., Christensen Sand & Gravel Co., McCann Sand & Gravel Co., Einung Sand & Gravel Co., and Overland Sand & Gravel Co. Seventeen commercial producers had outputs between 100,000 and 200,000 tons. Production was reported from 66 of the 93 counties.

Stone.—Output consisted almost entirely of crushed and broken limestone, half of which was used as aggregate for concrete and road bases. In terms of quantity consumed, cement manufacturing

TABLE 7.—Sand and gravel production in 1963, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Adams	200	$144	Kearney	108	$98
Antelope	69	69	Keith	157	122
Banner	115	86	Kimball	19	36
Boyd	14	9	Knox	200	154
Brown	61	67	Lancaster	35	35
Buffalo	878	830	Lincoln	280	324
Butler	198	202	Loup	11	11
Cass	456	395	Madison	284	274
Cedar	154	139	Merrick	214	208
Clay	244	220	Nuckolls	39	25
Colfax	93	87	Perkins	37	18
Cuming	223	225	Phelps	117	114
Custer	18	14	Pierce	144	114
Dawson	357	338	Platte	606	684
Dixon	46	74	Red Willow	64	61
Dodge	812	764	Richardson	10	10
Douglas	1,114	1,118	Saline	167	157
Fillmore	111	111	Sarpy	499	522
Franklin	124	108	Saunders	318	293
Frontier	19	19	Scotts Bluff	182	162
Furnas	98	98	Sioux	29	18
Gage	74	73	Stanton	81	90
Garden	48	29	Thayer	247	236
Garfield	10	10	Thomas	27	22
Greeley	27	25	Valley	40	39
Hall	586	550	Webster	52	47
Hamilton	128	128	Wheeler	10	10
Harlan	24	24	York	86	85
Hitchcock	24	21	Undistributed [1]	483	442
Holt	64	74			
Howard	27	24	Total	11,166	10,680
Jefferson	204	194			

[1] Includes the following counties for which figures are withheld to avoid disclosing individual company confidential data: Boone, Cheyenne, Hayes, Morrill, Nance, and Polk.

was the next largest use. Most of the riprap was used for Missouri River bank stabilization projects of the U.S. Army Corps of Engineers. The total output came from 34 quarries operated by 28 producers. Ash Grove Lime & Portland Cement Co., City Wide Rock & Excavation Co., Fort Calhoun Stone Co., and Hopper Bros. Quarries were the leading producers; none of these companies produced more than 1 million tons nor less than 200,000 tons. Cass County, with production of 2.2 million tons, accounted for 59 percent of the total output. Production from Lancaster, Nemaha, Otoe, Sarpy, and Washington Counties, each with an output between 100,000 and 500,000 tons, totaled 1.3 million tons, or 35 percent. The balance of 200,000 tons, or 6 percent, was produced in nine other counties.

Talc.—Crude talc from outside the State was ground by Sierra Talc Co. at its plant in Grand Island. The ground talc was sold principally for making ceramics, rubber, and paint. Some ground talc was exported.

Vermiculite.—Crude vermiculite from Montana was exfoliated by Western Mineral Products Co. at its Omaha plant and sold for use as loose-fill insulation, litter, plaster aggregate, and for making acoustical material.

TABLE 8.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	3,113	$2,701	2,759	$2,703
Paving	1,048	822	974	931
Fill	(1)	(2)	331	208
Other	225	129		
Industrial:				
Engine	1	(2)		
Other			(3)	(3)
Total	4,387	3,652	4,064	3,842
Gravel:				
Construction:				
Building	1,043	851	790	822
Paving	5,054	3,752	4,650	4,503
Railroad ballast			(4)	(4)
Fill	7	5	132	81
Other	117	80		
Miscellaneous	330	269	258	231
Total	6,551	4,957	5,830	5,637
Total sand and gravel	10,938	8,609	9,894	9,479
Government-and-contractor operations:				
Sand:				
Building	18	43	(1)	(2)
Paving	390	198	323	329
Total	408	241	323	329
Gravel:				
Building	4	3		
Paving	692	540	949	872
Fill	811	404		
Total	1,507	947	949	872
Total sand and gravel	1,915	1,188	1,272	1,201
All operations:				
Sand	4,795	3,893	4,387	4,171
Gravel	8,058	5,904	6,779	6,509
Total	12,853	9,797	11,166	10,680

[1] Less than 500 short tons.
[2] Less than $500.
[3] Figure withheld to avoid disclosing individual company confidential data; included with construction sand used as "Fill."
[4] Figure withheld to avoid disclosing individual company confidential data; included with construction gravel used as "Fill."

TABLE 9.—Stone sold or used by producers, by uses

Use	1962		1963	
	Short tons	Value	Short tons	Value
Dimension stone: Rubble	1,200	$1,980	16,295	$74,164
Crushed and broken stone:				
Riprap	792,920	1,127,678	851,911	1,171,119
Concrete and roadstone	1,758,346	3,078,408	1,661,340	2,833,739
Agriculture	124,585	198,616	(1)	(1)
Other	[2] 993,415	[2] 2,219,222	[3] 1,170,762	[3] 2,113,432
Total	3,669,266	6,623,924	3,684,013	6,118,290
Grand total	3,670,466	6,625,904	3,700,308	6,192,454

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes stone used in asphalt filler, cement, feed, mineral filler, paint, and rubber filler.
[3] Includes stone used in cement, feed, other filler, paint, and rubber filler.

METALS

Lead, silver, antimony, bismuth, and some metallic byproducts were recovered at the American Smelting and Refining Co. lead-silver refinery in Omaha from lead bullion and other lead-bearing materials from out-of-State sources.

REVIEW BY COUNTIES

Table 10 shows the kinds and total value of the minerals produced in the counties with significant mineral production and mineral-industry activity are discussed.

Banner.—Petroleum production, worth $14.3 million, accounted for 97 percent of the county value, and the chief cause for the rise in county value was an increase in petroleum production of 300,000 barrels to a total of 5.1 million barrels; surpassed only by production in Kimball County. The output came from 65 oilfields, 6 of which extended into other counties. The Singleton oilfield produced 1.1 million barrels, nearly twice the 1962 output, and was the largest producing oilfield in the county. It was one of three oilfields in the State with an output of 1 million barrels or more. Kenmac, Willson Ranch, Vowers, Vedene, Edwards, and Lewis, in order of output, were the only oilfields within the county that produced between 100,000 and 1 million barrels. Barrett, Olsen, and Ostgren oilfields, partly situated in the county, also produced between 100,000 and 1 million gallons.

TABLE 10.—Value of mineral production in Nebraska, by counties [1]

County	1962	1963 [2]	Minerals produced in 1963 in order of value
Adams	$48,000	$144,000	Sand and gravel.
Antelope	43,500	69,000	Do.
Banner	[3] 14,343,000	14,837,000	Petroleum, LP gases, natural gasoline, sand and gravel.
Boone	(4)	(4)	Sand and gravel.
Boyd	(4)	9,000	Do.
Brown	(4)	67,000	Do.
Buffalo	483,400	830,000	Do.
Butler	167,100	202,000	Do.
Cass	[3] 16,778,654	14,967,777	Cement, stone, sand and gravel, clays.
Cedar	118,400	139,000	Sand and gravel.
Cherry	234,700	50	Gem stones.
Cheyenne	[3] 12,773,000	11,913,000	Petroleum, natural gas, LP gases, natural gasoline, sand and gravel.
Clay	137,300	220,000	Sand and gravel.
Colfax	87,200	87,000	Do.
Cuming	119,800	(4)	Sand and gravel, stone.
Custer	51,055	(4)	Pumice, sand and gravel.
Dawes	165	2,660	Gem stones.
Dawson	189,100	338,050	Sand and gravel, gem stones.
Deuel	[3] 717,000	551,000	Natural gas, LP gases, natural gasoline.
Dixon	(4)	98,358	Sand and gravel, stone.
Dodge	773,200	764,000	Sand and gravel.
Douglas	1,053,200	1,153,262	Sand and gravel, stone, clays.
Dundy	74,000	51,000	Petroleum.
Fillmore	59,800	111,000	Sand and gravel.
Franklin	(4)	108,000	Do.
Frontier	25,600	19,000	Do.
Furnas	58,400	104,000	Sand and gravel, petroleum.
Gage	273,419	204,821	Stone, sand and gravel.
Garden	56,300	52,000	Sand and gravel, petroleum.
Garfield	----------	10,000	Sand and gravel.
Greeley	14,000	25,000	Do.
Hall	(4)	(4)	Sand and gravel, lime.
Hamilton	68,100	128,000	Sand and gravel.
Harlan	279,100	185,000	Petroleum, sand and gravel.
Hayes	27,200	37,000	Do.
Hitchcock	567,500	627,000	Do.
Holt	64,300	74,000	Sand and gravel.

See footnotes at end of table

TABLE 10.—Value of mineral production in Nebraska, by counties[1]—Continued

County	1962	1963[2]	Minerals produced in 1963 in order of value
Hooker		(4)	Stone.
Howard		$24,000	Sand and gravel.
Jefferson	(4)	(4)	Sand and gravel, clays.
Kearney	$69,800	98,000	Sand and gravel.
Keith	73,200	122,000	Do.
Kimball	[3] 22,739,900	19,827,000	Petroleum, LP gases, natural gasoline, natural gas, sand and gravel.
Knox	102,325	154,000	Sand and gravel.
Lancaster	226,302	283,330	Stone, clays, sand and gravel, gem stones.
Lincoln	307,200	361,050	Sand and gravel, petroleum, gem stones.
Loup	24,000	11,000	Sand and gravel.
Madison	424,800	274,000	Do.
Merrick	142,200	208,000	Do.
Morrill	3,708,100	4,100,000	Petroleum, sand and gravel, lime.
Nance	142,700	(4)	Sand and gravel.
Nemaha	(4)	(4)	Stone.
Nuckolls	(4)	(4)	Cement, sand and gravel.
Otoe	(4)	(4)	Stone, clays.
Pawnee	101,515	(4)	Stone.
Perkins	10,600	18,000	Sand and gravel.
Phelps	82,100	114,000	Do.
Pierce	96,700	114,000	Do.
Platte	493,000	684,000	Do.
Polk	79,900	(4)	Do.
Red Willow	19,863,400	12,408,000	Petroleum, sand and gravel.
Richardson	409,581	344,958	Petroleum, stone, sand and gravel, gem stones.
Saline	123,000	157,000	Sand and gravel.
Sarpy	1,336,023	1,039,656	Sand and gravel, stone.
Saunders	[3] 363,900	293,000	Sand and gravel.
Scotts Bluff	356,279	2,217,000	Petroleum, lime, sand and gravel.
Seward	(4)	(4)	Stone.
Sheridan	300		
Sioux	13,800	18,070	Sand and gravel, gem stones.
Stanton	118,300	90,000	Sand and gravel.
Thayer	205,100	236,000	Do.
Thomas	(4)	22,000	Do.
Thurston	(4)	(4)	Stone.
Valley	28,000	39,000	Sand and gravel.
Washington	(4)	(4)	Stone.
Webster	(4)	47,000	Sand and gravel.
Wheeler		10,000	Do.
York	78,100	85,000	Do.
Undistributed[5]	[3] 6,967,177	7,178,841	
Total	[3] 108,373,000	98,706,000	

[1] The following counties are not listed because no production was reported: Arthur, Blaine, Box Butte, Burt, Chase, Dakota, Gosper, Grant, Johnson, Keya Paha, Logan, McPherson, Rock, Sherman, and Wayne.
[2] Value of petroleum is preliminary.
[3] Revised figure.
[4] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[5] Includes some sand and gravel (1962), and gem stones that cannot be assigned to specific counties, and values indicated by footnote 4.

Exploration drilling was only about half that of 1962. Three of the 22 wildcat wells completed were discoveries for a success ratio of 1:7. The discoveries were all in the J sandstone (Cretaceous) formation.

Production of natural gas liquids, consisting of LP gases and natural gasoline, decreased 1.5 million barrels. The LP gases and natural gasoline were produced at the Banner natural gasoline plant of Antelope Gas Products Co. from casing head gas obtained from oilfields within the county.

Sand and gravel production, by the Banner County Highway Department, went from 10,100 tons in 1962 to 115,000 tons in 1963, owing to increased road work.

Buffalo.—Sand and gravel was produced from 10 commercial and 4 Government-and-contractor operations. The county was ranked second in production among the counties. Production totaled 878,000 tons. Much of the sand and gravel was used in constructing Interstate Highway 80 within the county.

Cass.—With an output of 2.2 million tons of stone, the county was the principal source of stone produced in the State. Of the four mineral commodities produced in the county, only clay had an increase in production. Cement, the most valuable mineral commodity, was produced by Ash Grove Lime & Portland Cement Co. at its Superior plant. Cement rock (limestone) and shale (clay) for maufacturing cement were mined by the company from deposits near the cement plant. The cement-rock operation of the company had the largest production of all stone operations in the State. In addition to this operation, 12 other stone operations were active. Of the stone producers, Ash Grove Lime & Cement Co., Heebner Quarries, Hopper Bros. Quarries, United Mineral Products Co., and United Rock Construction, Inc., produced between 100,000 and 1 million tons. Sand and gravel was produced by Lyman-Richey Sand & Gravel Corp. (Plant 5) and Western Sand & Gravel Co. (Cedar Creek and South Bend plants). The operation of Lyman-Richey Sand & Gravel Corp. was the largest sand and gravel producer in the State.

Cheyenne.—Because of a 447,000-barrel decrease, the value of petroleum production dropped about $1.3 million below that of 1962. Partly offsetting the reduction in value of petroleum was an increase of about $0.5 million in natural gas production, which rose 2.7 million cubic feet above that of 1962. Natural gas liquids and sand and gravel dropped in output.

Petroleum production was 3.2 million barrels from 65 oilfields, 4 of which were partly situated in other counties. None of the oilfields had production of 250,000 barrels or more. Fourteen oilfields had individual production between 100,000 and 250,000 barrels.

Casing head gas from oilfields and dry natural gas from gasfields in the county were processed at The Marathon Oil Co. Huntsman and West Sidney plants, for obtaining natural gas liquids (LP gases and natural gasoline).

In September, the Nebraska Oil and Gas Conservation Commission approved the use of the Huntsman gasfield as a natural gas storage reservoir by Kansas-Nebraska Natural Gas Co., Inc.

Sand and gravel was produced by Ready-Mix Concrete Co. of Sidney.

Deuel.—Marketable natural gas and natural gas liquids, consisting of LP gases and natural gasoline, were obtained from processing dry natural gas and casing head gas at the Big Springs plant of Kansas-Nebraska Natural Gas Co., Inc. The dry natural gas came from the Big Springs gasfield, and the casing head gas from nearby oilfields.

Dodge.—The county had the third largest output of sand and gravel in the State. Six commercial operations accounted for the output.

Douglas.—With a sand and gravel production of 1.1 million tons the county had the largest output in the State. From nine commercial operations, sand and gravel production, valued at $1.1 million, accounted for 97 percent of the county minerals production values. About three-fourths of the sand and gravel was used for building construction, virtually the same as in 1962. The balance of production went for road construction, fill, and miscellaneous uses. Some clay was mined by the Omaha Brick Works, and some crushed limestone was produced by the Welsh Stone Co. Western Mineral Products Co. ex-

panded perlite and exfoliated vermiculite at its Omaha plant; the crude raw materials were obtained from mines outside the State. Asarco processed lead bullion and other lead-bearing materials from out-of-State sources at its lead-silver refinery in Omaha.

Hitchcock.—Ninety-seven percent of the county value of mineral production was derived from the output of petroleum. Of the seven producing oilfields, the Reiher was responsible for 214,000 barrels, 60 percent of the total output. Output of sand and gravel, produced from three commercial operations, was 24,000 tons.

Kimball.—The county accounted for one-fifth of the State mineral production value. The petroleum output of 6.8 million barrels was 1.7 million barrels more than that of any other petroleum-producing county, but nearly 1 million barrels below that of 1962. Ninety-seven percent of the county value of mineral production was derived from petroleum. Of the 318 oilfields in the State, 128, including 7 extending into other counties, were in Kimball County. The Sloss oilfield, largest in output, was one of three oilfields in the State with production greater than 1 million barrels. Twenty oilfields, including three situated partly in other counties, produced between 100,000 and 1 million barrels.

Four of the 36 wildcat wells were discoveries, for a success ratio of 1:9. All of the new fields were in the J sandstone (Cretaceous) formation.

Output of natural gas dropped 1.8 million cubic feet below that of 1962. Production of natural gas liquids increased 795 gallons in output. The natural gas liquids, consisting of LP gases and natural gasoline, were produced at the Kimball natural gasoline plant of Antelope Gas Products Co.

Sand and gravel production was greater than in 1962; output was produced by Wilson Bros., Inc.

Morrill.—Petroleum output was valued at $3.8 million and represented 93 percent of the county value of mineral production. Output came from 15 oilfields, including 2 extending into other counties.

Outputs of sand and gravel and lime were greater than in 1962. Sand and gravel was produced from one commercial and one Government-and-contractor operation. The Great Western Sugar Co. produced lime at its Bayard plant for making sugar from sugar beets.

Nuckolls.—Portland and masonry cements were manufactured at the Superior plant of Ideal Cement Co. Sand and gravel was produced by C. F. Bondegard.

Red Willow.—Because of a decrease of $7.4 million in value of petroleum production, the county lost its second-place rating in value of mineral production, and dropped to fourth place. Output of petroleum from the Sleepy Hollow oilfield, the largest in the State, decreased 2.6 million barrels but still accounted for 72 percent of county output. At the beginning of the year, the Nebraska Oil and Gas Conservation Commission decided against establishing a production rate for the Sleepy Hollow oilfield. Sixteen other oilfields accounted for 28 percent of the output; four of these oilfields, including the newly discovered Northwest Sleepy Hollow, had individual production between 100,000 and 600,000 barrels.

With 94 completions, 30 wildcat and 64 development wells including 1 service well, the county led in the number of wells drilled dur-

ing the year; however, this number was 37 less than in 1962. The Northwest Sleepy Hollow oilfield, one of the two important discoveries made during the year, accounted for 217,000 barrels in 1963. The discovery well, No. 1 Emrich (sec 15, T 3 N, R 27 W), completed in June, initially pumped 350 barrels of oil per day. The producing zone was in the Basal sandstone (Pennsylvanian) formation from 3,431 to 3,433 feet; weathered granite was encountered at 3,439 feet.

Production of sand and gravel from three commercial operations was 64,000 tons, 43,000 tons below that of 1962.

Richardson.—Petroleum was produced from three oilfields (Barada, Dawson, and Falls City) in the southeastern part of the State. A discovery in Jackson County, Kans., in a new horizon, generated some interest in the Forest City basin region in which Jackson and Richardson Counties are located. The Richardson County Highway Department produced crushed limestone for road construction and maintenance. Findlay Quarries produced some sand for fill and gravel for use on roads. Specimens of agate and petrified wood were reportedly collected by a mineral dealer.

Sarpy.—The mineral production value was derived equally from stone and sand and gravel. Sand and gravel production decreased 362,000 tons from that of 1962; three-fourths of the drop was in the output used for building construction and one-fourth in that used for road construction, fill, and miscellaneous uses. Stone production increased 13,000 tons over that of 1962; output of stone was chiefly crushed limestone used as aggregate for making concrete and road bases. The sand and gravel was from six operations, and the stone was from four.

Scotts Bluff.—The county value of mineral production went from $400,000 in 1962 to $2.2 million in 1963, exceeding the $1 million mark for the first time. This gain resulted chiefly from the increase of 551,000 barrels in petroleum production from four oilfields, including the newly discovered Cedar Valley oilfield which had an output of about 348,000 barrels. The Canal oilfield had production of slightly more than 200,000 barrels. Discovery of the Canal oilfield in 1962 spurred exploratory drilling from 10 wildcat wells drilled in 1962 to 45 in 1963, the greatest number of wildcat wells drilled in a county during the year. Although only three discoveries resulted from the exploratory drilling, the Cedar Valley oilfield was probably the most significant made in the State during the year. The oilfield was found in April by the No. 1 Schubert well (sec 21, T 21 N, R 55 W). The producing zone was the J Sandstone (Cretaceous) formation between 5,096 and 5,099 feet. The well bottomed in the same formation at 5,190 feet. Initial production was 76 barrels of oil per day plus 5 percent water.

Crude petroleum from oilfields in Banner County and southeastern Wyoming was refined at the Scottsbluff plant of the Cooperative Refinery Association.

Output of sand and gravel, 182,000 tons, was produced from six commercial and two Government-and-contractor operations. Except for about 30,000 tons for building construction, railroad ballast, and miscellaneous uses, the output was used for road construction and

maintenance. The Great Western Sugar Co. produced lime at its Gering, Mitchell, and Scottsbluff plants for making sugar from sugar beets.

Washington.—Stone was produced by Fort Calhoun Stone Co. at its limestone quarry at Fort Calhoun, the second largest stone operation in the State.

The Mineral Industry of Nevada

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, United States Department of the Interior, and the Nevada Bureau of Mines

By L. E. Davis,[1] Roy Y. Ashizawa,[2]

NEVADA'S mineral production rose to $85.4 million in 1963, the highest since 1957. The increase of $2.4 million over the 1962 figure was almost evenly divided between the metals and nonmetals groups. Metals represented 70 percent of the total value and advanced 2 percent over 1962; nonmetals accounted for over 29 percent, a 6-percent increase. Mineral fuel (petroleum) output declined 36 percent in value despite a new discovery that extended Nevada's only producing field.

TABLE 1.—Mineral production in Nevada [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	137,727	$954	120,450	$760
Copper (recoverable content of ores, etc.)—do	82,602	50,883	81,738	50,351
Gem stones	(2)	100	(2)	100
Gold (recoverable content of ores, etc.)—troy ounces	62,863	2,200	98,879	3,461
Gypsum—short tons	817,000	2,952	890,000	3,216
Iron ore (usable)—long tons, gross weight	617,000	3,238	772,133	3,921
Lead (recoverable content of ores, etc.)—short tons	771	142	1,126	243
Mercury—76-pound flasks	6,573	1,257	4,944	937
Perlite—short tons	25,067	205	222,910	192
Petroleum (crude)—thousand 42-gallon barrels	141	(3)	[4] 96	(3)
Sand and gravel—short tons	7,850,000	9,655	9,688,000	10,513
Silver (recoverable content of ores, etc.)—troy ounces	245,164	266	214,976	275
Stone—short tons	722,000	1,220	639,000	1,101
Sulfur ore—long tons	(3)	(3)	586	11
Talc and soapstone—short tons	6,157	55	4,243	50
Tungsten concentrate—short tons, 60 percent WO_3 basis	156	234	(3)	(3)
Zinc (recoverable content of ores, etc.)—short tons	281	65	571	131
Value of items that cannot be disclosed: Clays, diatomite, fluorspar, lime, magnesite, molybdenum concentrates (content), pumice, salt, uranium ore, and values indicated by footnote 3		[5] 9,648		10,178
Total		[5] 83,074		85,440

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Preliminary figure.
[5] Revised figure.

[1] Physical scientist, Bureau of Mines, San Francisco, Calif.
[2] Mineral specialist, Bureau of Mines, San Francisco, Calif.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$71,124	1958	$71,989
1953	79,254	1959	69,094
1954	95,691	1960	75,360
1955	104,817	1961	79,493
1956	106,454	1962	79,502
1957	84,585	1963	80,953

TABLE 3.—Employment and injuries in the mineral industries [1]

Industry	Employees	Man-hours (thousands)	Injuries			Injury frequency rate [4]
			Fatal	Nonfatal	Total	
1962 [2]						
Metal mines and mills [5]	2,494	5,241	4	89	93	17.74
Nonmetal mines and mills	733	1,446		49	49	33.89
Stone quarries	144	216				
Sand and gravel operations	550	940		24	24	25.53
Total	3,921	7,843	4	162	166	21.17
1963 [3]						
Metal mines and mills [5]	2,439	5,366		79	79	14.72
Nonmetal mines and mills	711	1,624		28	28	17.24
Stone quarries	128	187		1	1	5.35
Sand and gravel operations	643	1,144		2	2	1.75
Total	3,921	8,321		110	110	13.22

[1] Excludes the mineral fuels industry and officeworkers. Data collected and compiled by the Federal Bureau of Mines in cooperation with the Nevada State Inspector of Mines.
[2] Final figures.
[3] Preliminary figures.
[4] Total number of disabling injuries during the year per million man-hours.
[5] Includes metallurgical plants to avoid disclosing individual company confidential data.

Exports continued as a major factor in the economy of Nevada's iron ore industry. Gold output rose, principally because of uninterrupted operation at the Getchell mine where process improvement boosted recovery. Copper production declined despite the treatment of larger quantities of ore as the average copper content of ores in White Pine County was lower. A marked rise in the output of sand

and gravel resulted from construction of two major highways that are a part of the Federal interstate system. Larger shipments of gypsum to Nevada and California wallboard plants, and of lime to southern California industrial plants, were recorded.

Exploration and development at metal mines and prospects continued at a high level. The Pumpkin Hollow iron deposits, Lyon County, were explored by United States Steel Corp. and by Utah Construction & Mining Co., which controlled iron ore deposits near Dayton where geological studies, mine layout, and beneficiation plans were almost completed. According to company reports, metallurgical tests showed the feasibility of producing iron ore pellets from the ore, and emphasis was directed toward development of an annual export market for 1 million tons of iron ore products. In November, Nevada-Barth Corp., one of the State's major iron ore producers, stopped all exploration and development. In northern Eureka County, Phillips Petroleum Co., Atlas Corp., Kerr-McGee Oil Industries, Inc., Sierra del Oro Mining Co., and M. M. & S. Exploration Co. searched for gold ores. Newmont Mining Co. reported its exploratory drilling program, begun in 1962, in the Maggie Creek area had delineated sufficient gold ore to warrant a processing plant. A Federal Geological Survey report on exploration possibilities in the Unionville area, Pershing County, prompted an intensive search for silver ores by several companies and individuals. In the Silver Peak area, Esmeralda County, Mid-Continent Uranium Co. was exploring for silver, a property that had been drilled previously by another mining company. Intensive exploration for copper ores was underway in Lyon County, by Norlex Mines, Ltd.; in Lander County, by Duval Sulphur & Potash Co.; and in Nye County, by Homestake Mining Co. Silver King Mines, Inc., White Pine County, was nearing completion of a pilot mill, designed to treat silver ores from company-owned properties. Exploration for beryllium ore was limited to a drilling program at the Leavitt claims, Clark County. At yearend, The Anaconda Company had abandoned its lease and option on the Mt. Wheeler beryllium property, White Pine County.

At Fernley, Nev., construction began on what will be Nevada's first cement plant, designed primarily to serve the needs of the northern and central areas of the State. Baroid Division, National Lead Co., completed construction of a barite processing plant at Dunphy, Eureka County. In the Ash Meadows area, K–B Mining Corp. was developing a clay deposit and had a processing plant under construction.

Employment and Injuries.—Bureau of Mines statistics, collected and compiled in cooperation with the Nevada State Inspector of Mines, revealed an average total employment figure unchanged from 1962 although variations existed in individual classifications. In 1963, the average work week was 35 minutes longer and man-hours rose 6.1 percent.

No fatalities were reported in 1963; nonfatal lost-time injuries dropped from 162 to 110, and the injury frequency rate fell to 13.22 disabling injuries per million man-hours from 21.17 in 1962. A report from the Nevada Employment Security Department showed average weekly earning in the mineral industries at $130.38, up $7.45, and an average hourly wage of $3.05, 13 cents higher than in 1962.

The Bureau of Mines completed health and safety study of metal and nonmetal mines and submitted a report to the Congress in response to Public Law 87–300. Copies of this report are available for review at all Bureau of Mines Health and Safety District and Subdistrict offices.

Consumption, Trade, and Markets.—Each of Nevada's 17 counties yielded 3 or more mineral commodities. Production reports were received for 26 different commodities: Metal ores and concentrates—10; nonmetalic minerals—15; and mineral fuel—1. With few exceptions, metal ores, concentrates, and residues were processed in out-of-State mills and smelters. All usable iron ore was shipped to steel plants outside the State or was exported. One smelter (copper) was located in the State and was dependent on Nevada ores. A tungsten carbide plant utilized tungsten concentrates produced in Nevada and elsewhere, an electrolytic manganese dioxide plant operated on ores received from out-of-State sources, and a titanium metal plant used imported minerals as a raw material source.

Although many nonmetals were entirely consumed or processed within the State, there were notable exceptions. The entire talc and fluorspar outputs were shipped to California customers. Most of the barite and perlite and much of the gypsum and sulfur were shipped out-of-State in crude form. All the diatomite and magnesite was processed before shipment outside the State. Some limestone and much of the lime produced went to consumers in California and Arizona. All crude oil was consigned to a California refinery.

Nevada was dependent on processors outside the State for all its mineral fuels and metals requirements, and virtually all its nonmetals needs other than materials of construction.

Legislation and Government Programs.—Public land orders restored about 427,000 acres of land to mineral location and leasing under U.S. mining laws, 272,000 acres of which was restored by the U.S. Navy on the Humboldt-Pershing County line. Land orders also withdrew about 30,000 acres from eight counties for use by various Federal agencies. Of this total, the Forest Service withdrew 21,000 acres from mineral location on the Douglas-Ormsby County line, and the Atomic Energy Commission withdrew about 7,000 acres in Clark County. During 1963, Nevada received U.S. Treasury checks totaling $178,520.69 in bonuses, royalties, and rentals—about $30,000 less than in 1962—from mineral leasing on Federal lands within the State borders.

Under the Lead-Zinc Stabilization Program, authorized under Public Law 87–347, enacted October 3, 1961, eight Nevada producers had been certified since its enactment in October 1962. At yearend, four producers were awaiting re-application, one application had been withdrawn, one was awaiting clarification of production figures, and two were expected to be re-issued early in 1964. Only one application, that of Consolidated Eureka Mining Co. (Diamond mine), Eureka County, was certified in 1963. Payments were made to one active participant (Chas. A. Vaccaro, Mountain View mine, Eureka County), and one inactive participant (Ala & Daz, Delno mine, Elko County). Total 1963 payments were for 54 tons of lead and 376 tons of zinc.

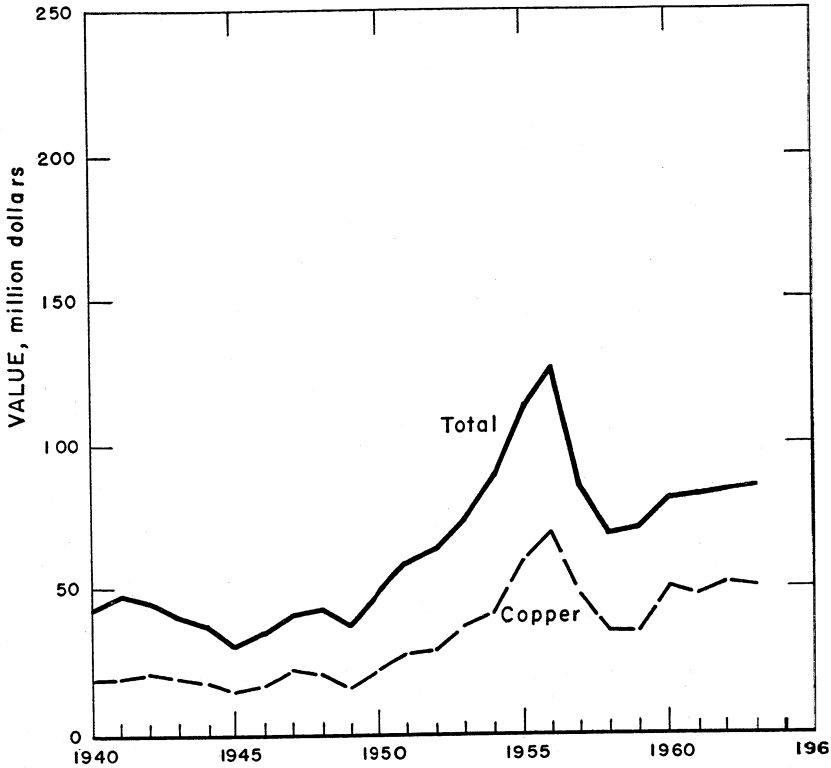


FIGURE 1.—Value of copper, and total value of mineral production in Nevada, 1940–63.

Federal Bureau of Mines activities continued at metallurgical research facilities in Reno and Boulder City, and mining research, and mineral resource development offices in Reno.

Several developmental tests of nuclear explosives were conducted by the Atomic Energy Commission (AEC) under the Plowshare Program. A mining engineer from the Area VI Mineral Resource Field Office in Reno, Nev., cooperated in preshot and postshot mine surveys for AEC for each of the projects conducted in Nevada. All mining properties within a 10-mile radius of ground zero and the principal mines within a 20-mile radius were visited.

Fieldwork by the Bureau's Reno Mining Research Laboratory and the Kennecott Copper Corp. on the slope stability research project at the corporation's Kimbley Pit, White Pine County, was completed in 1963. Laboratory work on the project was still in progress.

For the year ending December 31, 1963, the Office of Minerals Exploration (OME) received 55 requests for application forms by persons interested in exploring for minerals in Nevada. Six applications were processed during the period—four for gold-silver, one for beryllium-tungsten, and one for gold-silver-lead-antimony. After an on-site examination by the OME field officer, four applications were denied, one was cancelled when the applicant failed to submit a revised

application, and the other was pending at yearend. No contracts were executed in 1963.

Section 353.120 of Nevada State Mining Laws, on payment of refunds authorized by the State Board of Examiners, was revised by the Nevada Legislature in 1963. Several sections under chapter 231 were renumbered.

Water.—During 1963, the Bureau of Mines conducted a national water survey of the mineral industries for calendar year 1962. The results of this survey in Nevada, shown on tables 3 and 4, disclose that metal mines and mills used over 87 percent of the new water requirements in the State's mineral industries, accounted for more than 85 percent of recirculated and discharged water, and consumed more than 91 percent of the total. The results not only confirmed but emphasized the need for large volumes of water in processing metal ores using present methods of treatment. At yearend, a water study was in progress in Nevada, designed to supplement and extend the results of the 1962 survey.

Little activity in the development of thermal power sources was reported. Magma Power Co. recorded a lease in the Brady Hot Springs area, Churchill County, and discontinued drilling at both Darrough Hot Springs, Nye County, and the Small Geysers area, Eureka County, which had been under consideration by Sierra Pacific Power Co. as a possible energy source for generating of electricity. However, any plant construction program in the area must await determination of power requirements of the Ruby Hill mine at Eureka, according to a report from Magma Power Co. Western Geothermal Co. was deepening an exploratory geothermal well on the shore of Pyramid Lake, Washoe County. Further tests on the heretofore disappointing well were to be made.

TABLE 4.—Water use of the mineral industry,[1] by counties, in 1962

(Million gallons)

County	New water	Recirculated water	Total water	Discharged water	Consumed water
Churchill	(2)		(2)	(2)	
Clark	682	365	1,047	471	211
Douglas	29	213	242	22	7
Elko	14		14	12	2
Esmeralda	78		78	78	
Eureka	(2)		(2)	(2)	
Humboldt	294	200	494	191	103
Lander	61	50	111	46	15
Lincoln	4		4	4	(3)
Lyon	1,794	968	2,762	128	1,666
Mineral	3		3	2	1
Nye	118	21	139	62	56
Ormsby	(2)		(2)	(2)	
Pershing	84		84	83	1
Storey	60		60	32	28
Washoe	76		76	72	4
White Pine	5,279	2,000	7,279	4,007	1,272
Undistributed	1		1	1	
Total [4]	8,577	3,817	12,394	5,211	3,366

[1] Excludes the mineral fuels industry.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Less than 1 million gallons.
[4] In some instances data do not add to totals shown because of rounding.

TABLE 5.—Water use in the mineral industries,[1] by industry, in 1962

(Million gallons)

Industry	New water	Recirculated water	Total water	Discharged water	Consumed water
Metal mines and mills	7,515	3,281	10,796	4,445	3,070
Nonmetal mines and mills	458	221	679	234	224
Stone quarries	(2)		(2)	(2)	
Sand and gravel operations	604	315	919	532	72
Total	8,577	3,817	12,394	5,211	3,366

[1] Excludes the mineral fuels industry.
[2] Less than 1 million gallons.

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—Activity at antimony properties was limited to exploration and development at the Silvermonial deposit in the Reveille district east of Tonopah, Nye County. The work concentrated on a search for an antimony-silver ore body.

At Austin, the operator of the White Caps mine at Manhattan was renovating the Clifton concentrator in preparation for milling antimony-silver ores.

Beryllium.—In Clark County, exploration was continued on the Leavitt claims in the Virgin Mountains by Beryllium Associates but no work was done on the Taglo claims or the Western Beryl of Nevada properties. The Anaconda Company announced termination of its interest in the beryllium properties (formerly Mt. Wheeler Mines, Inc.) in White Pine County, as of December 31, 1963. No activity was reported at the Swallow property and on the Bida and Robison claims in the same area.

Copper.—Production of recoverable copper was only 1 percent below that of 1962, but the decline amounted to more than $500,000. This decrease was attributed to lower copper content of ores mined and treated in White Pine County despite a larger tonnage processed as well as to sharp curtailment of copper leaching in Lander County. A high percentage of the total copper recovered came from four mines—the Yerington mine, Lyon County; the Liberty pit, White Pine County; the Bristol mine, Lincoln County; and the Copper Canyon property, Lander County. A few tons of copper was recovered from residues shipped to a smelter by Manganese, Inc. The residues resulted from cleanup operations at the company's former Clark County manganese ore processing plant. Lesser quantities of copper were recovered as a byproduct from lead ores mined in Elko and Pershing Counties and from silver ore mined in Pershing County, as well as from mine dump material from a lead-zinc property in Nye County.

Exploration for copper ore was conducted by Homestake Mining Co. in the Low Springs area, Nye County and by Duval Sulphur & Potash Co. in the Copper Canyon-Copper Basin area, Lander County. Norlex Mines, Ltd., of Toronto, Canada, announced plans for exploratory drilling in the Mason area, Lyon County.

At Weed Heights, the Yerington mine of The Anaconda Company operated without interruption. Capacity of the sulfide concentrator was increased from 5,000 to 6,000 tons daily, and treatment of oxide ore continued at a capacity rate of 12,500 tons daily. In White Pine County, Nevada Mines Division, Kennecott Copper Corp., set a new average in daily ore production and milling rate despite a high waste to ore ratio.

Gold.—Gold output rose 57 percent above that of 1962. Much of the increase was credited to the Getchell mine, Humboldt County, where process improvement raised the recovery factor. About 59 percent of all recovered lode gold came from gold ores of 15 mines; over 40 percent came from byproduct recovery in treating copper ores, and the remainder came from all other sources.

Placer gold was recovered from one dragline operation in Pershing County, one dragline operation in Washoe County, a drift mine and a nonfloating washing plant in Nye County, byproduct recovery at a sand and gravel preparation plant in Lyon County, and several small-scale hand operations.

Exploration for gold ores was under way at properties in eight counties—Clark, Elko, Esmeralda, Eureka, Humboldt, Nye, Pershing, and Washoe. Newmont Mining Corp. reported that 140,000 feet of exploratory diamond drilling in the Maggie Creek area, Eureka County, had delineated sufficient ore to justify a mill. The mine will be an open pit. Laboratory tests indicate that cyanidation will yield the best recovery.

TABLE 6.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing [2]		Material sold or treated [3] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
1954–58 (average)	119	11	10,893	80,372	$2,813	858,100	$777
1959	67	10	8,788	113,443	3,971	611,135	553
1960	72	9	12,013	58,187	2,037	707,291	640
1961	62	10	12,067	54,165	1,896	388,426	359
1962	39	4	13,121	62,863	2,200	245,164	266
1963	37	7	13,676	98,879	3,461	214,976	275
1904–63 [4]			[5]	15,329,000	384,535	316,773,330	217,804

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	74,771	$50,120	4,569	$1,300	3,315	$836	$55,846
1959	57,375	35,228	1,357	312	217	50	40,114
1960	77,485	49,745	987	231	420	108	52,761
1961	78,022	46,813	1,791	369	453	104	49,541
1962	82,602	50,883	771	142	281	65	53,556
1963	81,738	50,351	1,126	243	571	131	54,461
1904–63 [4]	2,893,150	1,156,692	393,547	62,673	483,925	93,619	1,915,323

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings, or slimes retreated, and ore and old tailings shipped to smelter during calendar year indicated.
[2] Excludes itinerant prospectors, "snipers," "high graders," and others who gave no evidence of legal right to property.
[3] Does not include gravel washed.
[4] The first satisfactory annual canvass of mine production was made in 1904.
[5] Data not available.

TABLE 6.—Mine production of gold, silver, copper, lead, and zinc in 1963, by counties, in terms of recoverable metals

County	Mines producing [1]		Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Troy ounces	Value	Troy ounces	Value
Clark	1		3	$105	(2)	(2)
Elko	4		13	455	(2)	(2)
Eureka	1				874	$1,118
Lander	3	1	637	22,295	20,429	26,131
Lincoln	3		17	595	5,211	6,666
Mineral	2				620	793
Nye	2	1	370	12,950	644	823
Pershing	4	3	233	8,155	6,934	8,869
Washoe	2	1	89	3,115	38	49
Undistributed [3]	15	1	97,517	3,413,095	180,226	230,531
Total	37	7	98,879	3,460,765	214,976	274,980

	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Clark	(2)	(2)	(2)	(2)	(2)	(2)	$105
Elko	(2)	(2)	(2)	(2)	(2)	(2)	455
Eureka			111,900	$12,085	998,300	$114,805	128,008
Lander	28,200	$8,686	173,000	18,684	61,100	7,027	82,823
Lincoln	(2)	(2)	21,300	2,300	(2)	(2)	9,561
Mineral			1,700	184	2,600	299	1,276
Nye	(2)	(2)	(2)	(2)	(2)	(2)	13,773
Pershing	(2)	(2)	(2)	(2)	(2)	(2)	17,024
Washoe							3,164
Undistributed [3]	163,447,800	50,341,922	1,944,100	209,963	80,000	9,199	54,204,710
Total	163,476,000	50,350,608	2,252,000	243,216	1,142,000	131,330	54,460,899

[1] Excludes itinerant prospectors, "snipers," "high-graders," and others who gave no evidence of legal rights to property.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes Douglas, Esmeralda, Humboldt, Lyon, Storey, White Pine Counties, and counties indicated by footnote 2.

Iron Ore.—A 25-percent rise in shipments of usable iron ore was due principally to increased output at the mine and concentrator of Standard Slag Co., Douglas County. Nevada-Barth Corp. worked the Barth mine, Eureka County, and the Section 15 property, Pershing County, and exported the entire output to Japanese iron and steel plants. The McCoy and Hancock mine, Lander County, yielded direct shipping grade iron ore that also was exported to Japan. Ore from the Iron King mine, Humboldt County, the State's only underground iron mine, was shipped to both domestic and foreign consumers. Nevada Iron Ore Co., Inc., operated a pit on the Section 32 property, Pershing County, put the mine-run ore over a magnetic pulley, and shipped the magnetic fraction to a domestic steel company.

Lead.—Recoverable lead output was 46 percent above that of 1962. More than 80 percent of the production was contained in residues resulting from cleanup operations at the site of the former ore processing plant of Manganese, Inc., Clark County. The residues were shipped to a Utah smelter for processing. Most of the remaining lead output was recovered in treating old tailings at the Galena lead mine, Lander County, and in treating zinc ore of the Mountain View mine, Eureka County. Small quantities of the metal were recovered in

TABLE 8.—Mine production of gold, silver, copper, lead and zinc in 1963, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Gold	15	357,568	57,071	5,623			
Gold-Silver	1	3	1	37			
Silver	7	225	77	14,152	400	8,300	11,700
Copper	5	13,312,956	39,598	165,834	163,462,400	15,800	14,700
Lead	4	352	8	5,445	2,500	95,300	21,800
Lead-silver	1	32	11	539		5,100	300
Lead-zinc	3	112	5	1,125	300	9,900	6,700
Zinc	1	1,573		874		111,900	998,300
Total	37	13,672,821	96,771	193,629	163,465,600	246,300	1,053,500
Other lode material:							
Gold (slag and matte)	[2]	14	997	174			800
Lead residue	[2]			552	10,400	1,832,900	26,600
Old tailings	[2]	3,496	243	20,367		172,800	61,100
Total	[2]	3,510	1,240	21,093	10,400	2,005,700	88,500
Total lode material	37	13,676,331	98,011	214,722	163,476,000	2,252,000	1,142,000
Placer	7	[3]	868	254			
Total all sources	44	13,676,331	98,879	214,976	163,476,000	2,252,000	1,142,000

[1] Details will not necessarily add to the totals shown, because some mines produce more than one class of material.
[2] From property not classed as a mine.
[3] 8,628 cubic yards.

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc, in 1963, by types of material processed and methods of recovery, in terms of recoverable metals

Type of material processed, and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Amalgamation and cyanidation: Ore	57,083	6,126			
Concentration and smelting of concentrates: Ore	38,971	163,469	159,794,000	6,500	3,600
Direct smelting:					
Old tailings	243	20,367		172,800	61,100
Ore	717	24,034	3,671,600	239,800	1,049,900
Lead residue		552	10,400	1,832,900	26,600
Slag and matte	997	174			800
Total	1,957	45,127	3,682,000	2,245,500	1,138,400
Placer	868	254			
Grand total	98,879	214,976	163,476,000	2,252,000	1,142,000

treating lead-silver and lead-zinc ores as well as dump material from a former lead-zinc operation. Most silver ores contained recoverable lead as did one copper-silver ore. Only four lead properties were active during the year. Rehabilitation work was underway at the Consolidated Eureka property, Eureka County, throughout the year but no ore was shipped.

Mercury.—Mercury production continued the decline begun in 1961 despite a higher average market price for the metal. Treatment of 20 percent less ore than in 1962 yielded 25 percent fewer flasks of mercury, and shipments dropped 39 percent. The Cordero mine, Hum-

boldt County, produced 96 percent of the State's mercury output. Only one other property, the Ione mine in Nye County, reported production of 100 flasks or more. Nine additional mines and prospects contributed to the State total. Considerable underground development was conducted at the Ione property.

TABLE 10.—Mercury production, by methods of recovery

Year	Direct-furnaced		Retorted		Unclassified [1] flasks	Total		Operating mines
	Ore (short tons)	76-pound flasks	Ore (short tons)	76-pound flasks		76-pound flasks	Value [2]	
1954–58 (average)	35,791	5,374	6,646	662	10	6,046	1,549,406	37
1959	44,935	6,287	6,022	869	----------	7,156	1,627,847	20
1960	47,734	6,981	5,307	840	----------	7,821	1,648,354	20
1961	103,088	13,705	26,013	353	1	7,486	1,479,308	21
1962						6,573	1,256,823	14
1963	42,768	4,908	356	36	----------	4,947	936,641	11

[1] Includes mercury recovered from miscellaneous dump material.
[2] Value calculated at average New York price.

Molybdenum.—Kennecott Copper Corp. recovered molybdenite in its McGill concentrator, White Pine County, as a byproduct in the treatment of copper ore mined in the nearby Robinson district. Shipments of molybdenite concentrate however, based on metal content, were virtually unchanged.

The Anaconda Company continued exploratory drilling on a reduced scale at the Hall molybdenum property, Manhattan district, Nye County.

Silver.—Output of recoverable silver was about 30,000 ounces less than in 1962. The decline was attributed to less production at White Pine County mines—principally lower byproduct recovery from copper ore and no reported shipments of silver ore from the Silver King mine. About 77 percent of all recoverable lode silver came from copper ores, 10 percent from the treatment of old lead tailings, 7 percent from silver ores, 2 percent each from gold and lead ores, and 2 percent from all other sources.

Operators explored for silver ores at properties in Clark, Esmeralda, Mineral, Nye, Pershing, and White Pine Counties. A Federal Geological Survey report [3] had indicated that significant bodies of silver ore may have been overlooked during earlier mining in the Unionville area, Pershing County. Copies of the report have been placed on file for inspection at Geological Survey libraries and at the Nevada Bureau of Mine's Office, University of Nevada, Reno, Nev.

Exploration was underway for silver ores during the last 6 months of 1963 at the Simon Mine, Mineral County, and the Tiger Lilly mine, Clark County. At East Ely, White Pine County, a pilot mill was under construction by Silver King Mines, Inc., to treat ores from properties in the Ward Mountain and Taylor districts that had been extensively explored by the company. The Sixteen-to-One property, Silver Peak district of Esmeralda County, was being explored by Mid-

[3] Wallace, Robert E., and Donald B. Tatlock. An Exploration Possibility at the Arizona mine, Pershing County, Nevada. Geol. Survey open-file report, 1963, 12 pp.

Continent Uranium Corp. throughout the year. Some exploratory drilling was done on this property in 1962 by another mining company.

Tungsten.—Tungsten mining was limited to one small operation in the Tonopah area, Nye County, where a few tons of ore was upgraded and sold to the tungsten carbide plant of Nevada Scheelite Division, Kennametal, Inc., near Rawhide, Mineral County. During the year, Nevada Scheelite used all its remaining tungsten concentrate stocks (produced in previous years) in the manufacture of carbide. All concentrate held in stock by Gabbs Exploration Co. and produced in other years from the Victory property, Nye County, was consigned to the chemical plant of Union Carbide Nuclear Co., Inyo County, Calif.

No sales were reported from stocks of concentrates held by Nevada Massachusetts Co., Pershing County, and partners in Minerva Scheelite Mining Co., White Pine County.

Uranium.—Apex Uranium, Inc., reactivated its Early Day mine near Austin, Lander County, and shipped ore to the Vitro Chemical Co. plant at Salt Lake City, Utah. All other uranium properties in Nevada were idle throughout the year.

Zinc.—Production of recoverable zinc was more than double the 1962 figure, and this was almost entirely due to increased output of zinc ore at the Mountain View mine, Eureka County. Over 87 percent of the total was obtained from this mine. Much zinc was recovered in the treatment of old tailings at the Galena lead mine, Lander County; from residues from the former Manganese, Inc. operation, Clark County; and as a byproduct from lead ores produced in Elko and White Pine Counties and copper-silver ore mined in Lincoln County. Lesser quantities were recovered from lead-zinc ore mined in Elko County and from dump material from a former lead-zinc operation in Nye County.

Other Metals.—No Nevada manganese ores were produced or shipped, but American Potash & Chemical Corp. at Henderson, Clark County, produced electrolytic (battery active) manganese dioxide from Mexican ores. Other electrochemical products produced by the company included sodium chlorate and ammonium perchlorate. Early in 1963, American Potash transferred the functions of its Henderson, Nev., laboratory to the company's Whittier, Calif., facility, thus concentrating research at Whittier and Trona, Calif.

No activity of any kind was reported from columbium-tantalum, titanium, and vanadium properties and prospects in the State, although the Clark County plant of Titanium Metals Corp. of America produced titanium metal and alloys using rutile imported from Australia. Some exploratory work was done in Lander County at the Overlook Group of nickel claims, but the R & D Group was idle.

Late in the year an operation was planned to recover placer tin in the Rabbit Hole district, Pershing County; however, no activity had been reported at yearend.

NONMETALS

Barite.—Production of primary barite dropped 29 percent. Although stocks at mines decreased, the tonnages sold and used were 12 percent below 1962 figures. Nearly 97 percent of all production came

from mines in Lander and Elko Counties. Major producers in Lander County were Magnet Cove Barium Corp., Inorganic Chemicals Division (FMC Corp.), Hullinger & Elquist, and D. A. Mining Co., which was a new producer in 1963. Baroid Division, National Lead Co., in Elko County, was the State's only other major producer. Lesser tonnages of crude barite were produced and shipped from the Horton claims, Humboldt County, the Yuba No. 1 unit, Lander County, and the Columbus (Noquez) property, Mineral County. Magnet Cove, a Lander County producer, operated the only grinding plant in Nevada, although Baroid had a plant under construction that was expected to be in operation shortly after the first of January 1964. Baroid's new plant was designed to replace a company mill at El Portal, Calif. The El Portal operation had been idle for about 10 years. Shipments also were made to grinding plants in California and Utah.

Cement.—Officials of the newly organized Nevada Cement Co. announced in August that a $15 million portland cement plant would be built at Fernley, Lyon County, and was expected to be producing by July 1964. The plant was designed for an initial capacity of 1.2 million barrels annually.

The plant site was selected after studies showed that most of the needed raw materials were obtainable in the immediate area and that iron ore was available in Pershing County about 65 miles away. At yearend, ground had been broken and foundations had been poured for several plant buildings, for the bulk storage silos, and for concrete piers for heavy plant equipment.

Clays.—Silicates Corp. mined bentonite from pits in Clark, Esmeralda, and Nye Counties and prepared the mineral for sale to paint, cosmetic, and pharmaceutical companies. Silicates Corp. also developed the Blanco mine in the Fish Lake Valley district by open pit and began production of bentonite clays in November. Industrial Minerals & Chemical Co. obtained fuller's earth from a Lyon County deposit and prepared the material for use as a pelletizing agent. The company also mined bentonite in Mineral County and prepared and sold it for use as a sealing compound in reservoirs and irrigation canals. In Washoe County, Reno Press Brick Co. mined fire and miscellaneous clays at its Faith-Geiger pits for use in manufacturing firebrick and block as well as building brick. At yearend the company ceased manufacturing operations and closed all its clay operations.

Lovelite Cosmetics, Inc., mined clay from its Nye County claims and used the material in the manufacture of cosmetics at its Clark County plant. K–B Mining Co., Las Vegas, Nev., developed a clay deposit in the Ash Meadows area, Nye County. At yearend, machinery for a preparation plant had been partially assembled at the property.

Diatomite.—Production of crude and prepared diatomite rose 9 percent. Much of the increase was credited to the tonnage of prepared material sold for various filler uses, which rose 24 percent. Six diatomite deposits were worked—one each in Churchill, Esmeralda, Lincoln, Mineral, Pershing, and Storey Counties. Production at the Lincoln and Mineral County deposits was small, and the output was sold for uses such as aggregate, soil aid, and filler in livestock and

poultry feeds. Shipments by major producers were about equally divided between domestic and foreign customers, and sold chiefly for filtration and filler uses.

Fluorspar.—Two fluorspar mines, both in Nye County, were active. Shipments of metallurgical grade fluorspar were made from the Crowell mine to West Coast steel plants. Monolith Cement Co. shipped lower grade mineral from the Goldspar property to its California plant. Mine output was less than in 1962 but shipments were higher as fluorspar was shipped from stockpile at the Carp mine, Lincoln County, although the mine was idle throughout the year.

Gem Stones.—Commercial and amateur collectors, mineralogical societies and clubs, as well as gem dealers collected more than 15 varieties of gem materials and mineral specimens in 12 counties. Principal gem materials collected, in order of decreasing quantity, were petrified wood, wonderstone, fluorspar, agate, and aragonite. Much of the petrified wood was collected near Mina, Mineral County. Churchill and Eureka Counties produced most of the wonderstone. All of the fluorspar was collected in the Iowa Canyon mining district, Lander County. Deposits in Churchill, Eureka, and Humboldt Counties yielded agate. Aragonite was found in Nye County. Other varieties of gem materials and specimens included signficant quantities of amethystine, argentite, carmelian, jadeite, jasper, mackayite, obsidian, opal, rhodonite, rhyolite, and turquoise.

Gypsum.—Nevada's output of crude gypsum came from two deposits in Clark County and from one deposit in Pershing County. Production in 1963 totaled over 890,000 tons. Larger shipments of crude gypsum were made to Nevada and California wallboard plants and to Western cement mills. Fibreboard Paper Products Corp. announced plans for construction of a multimillon dollar high-speed wallboard plant at its Apex quarry site, Clark County, with initial operation scheduled for early 1965. Extensive exploratory drilling at the Apex property early in 1963 confirmed an earlier ore reserve estimate of nearly 750 million tons.

Sales of agricultural gypsum for consumption in Nevada nearly doubled for the second consecutive year.

Lime.—U.S. Lime Products Division, The Flintkote Co., was the State's only lime producer. The company operated three plants in Clark County—at Apex (quicklime), at Sloan (hydrated lime), and at Henderson (both quicklime and hydrated lime). Production and shipments of lime rose substantially above 1962 figures. Although demand by the steel and construction industries were highest, appreciable gains were made in chemical and industrial sales, principally in the southern California area.

Magnesite and Brucite.—Basic, Inc., near Gabbs, Nye County, was the sole producer of magnesite. A high percentage of the crude magnesite output was consumed by the company in making caustic-calcined and refractory magnesias as well as various refractory products. The major consuming industries for caustic-calcined magnesias were oxychloride and oxysulfate cements, uranium ore processing, chemicals, synthetic rubber, rayon, fertilizer. Production, consumption, and sales were all below 1962 figures.

No brucite was mined but shipments of stockpiled mineral, previously beneficiated, were made by Basic, Inc. The quantities of brucite sold and used were somewhat higher.

Perlite.—Production and sales of crude perlite declined to the lowest levels in 10 years. Output was limited to two deposits in Lincoln County, but stockpiled material from a Pershing County deposit was expanded at a Washoe County wallboard plant. Some Lincoln County perlite was expanded in Las Vegas, Clark County, for concrete and plaster aggregate but most shipments went to out-of-State plants with 58 percent of the total going to California.

Development was in progress at the Perlex mine, Esmeralda County, by B & A Mining & Development, Inc., but no activity was reported by American Colloid Co. at its claims in Eureka.

Pumice (Volcanic Cinder).—Three deposits, one each in Nye, Ormsby, and Storey Counties, were sources for volcanic cinder for use principally as lightweight concrete aggregate. Naturalite Co., Carson City, Nev., invested nearly $300,000 in establishing its mine and plant east of Dayton, Lyon County. The plant product was marketed mostly for landscaping and roofing granules and in cement block. About 5 percent of the total output was sold in block form for decorative use.

There was no reported production from a pumiceous silica deposit near Panaca, Lincoln County. In previous years the deposit had supplied pozzolanic material for use in construction of the Glen Canyon Dam on the Colorado River.

Salt.—E. J. Huckaby contracted with Fallon Development Co., subsidiary of Leslie Salt Co., to produce solar evaporated salt from the surface of a dry lakebed near Sand Springs, Churchill County. The crude salt was sold locally to State and county agencies; to meat packers, dairies, and water softener services; and as a component of mixes used in surfacing roads.

Sand and Gravel.—Output of sand and gravel rose to 9.7 million tons from 7.9 million tons in 1962, because of demand for the materials near large-scale State and county road projects in Washoe, Churchill, Elko, and Clark Counties. Construction and maintenance activities of the Nevada State Highway Department alone consumed over 5.5 million tons of sand and gravel in 1963.

Nearly 8.1 million tons of sand and gravel was produced with portable plant equipment and over 1.6 million tons was produced at stationary operations.

Of the 109 active operations in the State, 43 were classified as commercial and 66 were Government-and-contractor operations. Ten of the 43 commerical operations produced 100,000 or more tons each, for a total output of 2,795,000 tons valued at $4,515,000, representing 29 and 43 percent of the total quantity and value, respectively.

Producers of industrial sands in the Overton area, Clark County, reported higher outputs of glass and molding sands.

Stone.—Stone production declined 12 percent to 639,000 tons because virtually no rubble, riprap, and railroad ballast was produced. Output of basalt, granite, and miscellaneous stone consisted mainly of road base material produced by public works crews and contractors.

Appreciable gains were reported in the production of limestone in Clark County and of dimension and crushed sandstone, quartz, and

quartzite in Clark, Elko, Humboldt, and White Pine Counties. Marble was quarried in Mineral County for terrazzo. In Lincoln County, the first reported shipments of marble were made to Las Vegas for use as building stone. Calcareous marl was quarried in Nye and Washoe Counties for filler and agricultural uses.

Sulfur.—The Crofoot sulfur deposit, Humboldt County, yielded nearly 600 tons of sulfur ore, sold exclusively for use as a soil aid. The deposit was the only active sulfur mine in the State. The Anaconda Company used stockpiled sulfur ore, previously mined from a California property, in its Lyon County acid plant.

Talc and Soapstone.—Four talc deposits and two soapstone properties, all in Esmeralda County, were active. Mine output and crude shipments were down 31 and 21 percent, respectively, from 1962. Shipments were all out-of-State, principally to California grinders and consumers.

TABLE 11.—Sand and gravel sold or used by producers by classes of operations and uses

Class of operation and use	1962		1963	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Glass	(1)	(1)	(1)	(1)
Molding	(1)	(1)	(1)	(1)
Building	690,095	$1,317,312	564,503	$1,321,716
Paving	(1)	(1)	(1)	(1)
Fill	25,217	23,342	77,015	43,835
Other	54,591	145,828	109,998	248,860
Gravel:				
Building	881,113	1,416,466	579,431	1,304,212
Paving	767,882	837,448	1,550,566	1,504,330
Railroad ballast	(1)	(1)	2,234	1,489
Fill	450,032	461,390	360,309	351,418
Other	998	1,942	(1)	(1)
Undistributed sand and gravel	178,304	653,078	301,216	900,538
Total sand and gravel	3,048,232	4,856,806	3,545,272	5,676,398
Government-and-contractor operations:[2]				
Sand:				
Building	8	27		
Paving	101,219	125,396	106,429	131,585
Fill	13,048	50,581		
Total	114,275	176,004	106,429	131,585
Gravel:				
Building	1,239	1,255	101	113
Paving	4,605,892	4,555,098	5,879,980	4,559,854
Fill	55,628	40,400	119,350	119,350
Other	25,000	25,000	36,620	25,660
Total	4,687,759	4,621,753	6,036,051	4,704,977
Total sand and gravel	4,802,034	4,797,757	6,142,480	4,836,562
All operations:				
Sand	1,033,526	2,280,672	1,094,805	2,503,176
Gravel	6,816,740	7,373,891	8,592,947	8,009,784
Grand total	7,850,266	9,654,563	9,687,752	10,512,960

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes figures for State, counties, municipalities, and other Government agencies.

MINERAL FUELS

Natural Gas.—At yearend, Nevada Northern Gas Co. was nearing completion of its 16-inch, 250-mile natural gas pipeline between Reno and the Nevada-Idaho border. The line will connect with the El Paso Natural Gas Co. pipeline and facilities at Mountain Home, Idaho. The planned distribution system will supply natural gas to consumers in Reno and northern Nevada towns.

Petroleum.—The State's entire crude oil production came from the Eagle Spring Field, Nye County. Late in 1963, Texota Oil Co. completed a well on a farm-out from Shell Oil Co. for a new zone discovery and an easterly extension of the field. Although the new well was a substantial producer, overall production dropped over 30 percent from 1962 as recovery declined in the older wells in the field. The discovery created much leasing activity, and Texota planned a second well south of the first.

REVIEW BY COUNTIES

Churchill.—Substantial tonnages of sand and gravel were produced and prepared for road projects, particularly Interstate Route 80 in the Brady's Hot Springs area and U.S. Highway 50 near Fallon and Frenchman. A portable sand and gravel plant at Fallon supplied virtually all the concrete aggregate used in local building construction. County crews quarried granite and basalt at several county locations and used the materials in road maintenance. Diatomite was mined southeast of Nightingale by Aquafil Co. and processed in the producer's Lyon County plant.

E. J. Huckaby, under contract with Fallon Development Co., mined solar evaporated salt from a dry lakebed at Sand Springs and sold the crude mineral to local consumers.

Clark.—Nearly 3.5 million tons of sand and gravel was produced at commercial pits and by public works crews and contractors, but the quantity prepared for building construction was less than in 1962. Highway projects in progress on Interstate Route 15 and U.S. Highway 95 consumed a large part of the output in both asphaltic and portland cement concrete. Producers of industrial sands in the Overton area shipped appreciable quantities for glass, foundry, and other uses. Relatively small tonnages of stone were quarried by highway contractors for use as riprap in road construction. Some unclassified stone was obtained from federally controlled land under permit from the Bureau of Land Management for local use in concrete. The Simon's Rainbow Quarries near Jean and Scott Placers near Crystal were sources for sandstone and quartz for flagging, building stone, and roofing granules. Limestone was quarried at Apex and Sloan by U.S. Lime Products Division, The Flintkote Co. The company operated gas-fired kilns at Apex to produce quicklime, some of which was hydrated in a batch hydrator at Sloan. At Henderson both gas- and oil-fired kilns and a continuous hydrator were used to produce quicklime and hydrated lime. Lime sales, particularly to customers in southern California, were substantially higher than in 1962.

TABLE 12.—Value of mineral production in Nevada by counties

County	1962	1963	Minerals produced in 1963 in order of value
Churchill	$258,197	$738,283	Sand and gravel, stone, salt, gem stones.
Clark	11,834,112	12,447,737	Sand and gravel, lime, gypsum, stone, lead, copper, zinc, silver, clays, gold, gem stones.
Douglas	865,185	1,619,136	Iron ore, sand and gravel, silver, gold, lead.
Elko	1,706,713	1,685,337	Sand and gravel, barite, stone, lead, silver, zinc, gem stones, gold, copper.
Esmeralda	657,669	642,283	Diatomite, talc and soapstone, gold, sand and gravel, silver, mercury, clays, gem stones, zinc.
Eureka	705,242	783,143	Iron ore, sand and gravel, zinc, lead, gem stones, silver.
Humboldt	2,827,369	3,804,220	Gold, mercury, iron ore, sand and gravel, stone, sulfur ore, gem stones, silver, barite, zinc.
Lander	1,147,444	948,468	Barite, iron ore, silver, gold, lead, sand and gravel, copper, zinc, uranium, gem stones.
Lincoln	418,230	205,699	Perlite, fluorspar, copper, silver, sand and gravel, diatomite, lead, zinc, stone, gold.
Lyon	26,036,192	26,404,690	Copper, diatomite, sand and gravel, silver, gold, clays, gem stones.
Mineral	217,868	79,106	Barite, sand and gravel, stone, diatomite, gem stones, clays, silver, zinc, lead, pumice.
Nye	[1] 1,919,832	1,522,366	Magnesite, sand and gravel, fluorspar, petroleum, pumice (volcanic cinder), mercury, gold, tungsten, clays, gem stones, silver, lead, zinc, copper, stone.
Ormsby	70,028	(2)	Sand and gravel, pumice (volcanic cinder).
Pershing	3,781,007	3,659,655	Diatomite, iron ore, gypsum, perlite, silver, gold, sand and gravel, lead, mercury, zinc, copper.
Storey	1,382,614	1,301,401	Diatomite, pumice, gold, silver.
Washoe	1,442,912	2,554,287	Sand and gravel, stone, clays, gold, silver, gem stones.
White Pine	27,713,378	26,889,349	Copper, gold, molybdenum, sand and gravel, silver, lead, stone, zinc.
Undistributed [3]	[1] 90,008	154,840	
Total	[1] 83,074,000	85,440,000	

[1] Revised figure.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes gem stones, mercury, gold, silver, lead, and zinc that cannot be assigned to specific counties and value indicated by footnote 2.

The Blue Diamond Co., division of The Flintkote Co., mined gypsum at Blue Diamond for use in its nearby wallboard plant and sold some of its output for cement and agricultural use. Fibreboard Paper Products Corp. mined gypsum at its Apex quarry and shipped it to company-owned wallboard plants and to out-of-State cement plants. Activity at the Leavitt Bros. gypsum deposit near Bunkerville was limited to assessment work. Bentonite mined from the Francis deposit near Las Vegas was sold for use in cosmetics and pharmaceuticals. The pit had been idle since 1959.

The El Dorado mine near Nelson yielded a few tons of ore from which gold was recovered. Cleanup operations at the former plant site of Manganese, Inc., produced residues that were shipped to a Utah smelter for recovery of silver, copper, lead, and zinc. At the Tiger Lilly mine near Crescent Peak, John Thacke was sinking a shaft in search for silver ore.

Douglas.—Standard Slag Co. operated its Minnesota iron mine and new treatment plant uninterruptedly throughout the year. As a result, shipments of usable iron ore were nearly double the 1962 figure. Except for a relatively minor tonnage of direct shipping ore, shipments were sinter product from the treatment plant. All of the ore was consigned for export to Japan.

Savage Construction Co. of Carson City was the principal sand and gravel producer. Most of the company's output was from pits near

Gardnerville and was used as concrete aggregate. State highway maintenance crews mined sand and gravel from a number of deposits for use in road repair.

Silver ore from the Arrowhead mine in the Mountain House district was treated to recover silver and gold. The Cowboy claims near Wellington yielded some lead ore that contained recoverable lead and silver.

Elko.—Sand and gravel production rose to nearly 2 million tons as road construction was at a comparatively high level. Substantial quantities of these materials were used on Interstate Route 80 near Elko, Halleck, and Wells, and on U.S. Highway 93 in the Wells area. Various sand and gravel pits were worked for material needed for road repair and maintenance by highway crews near Carlin and Elko. A relatively large tonnage of sand and gravel was produced by Bernadot's Red-E-Mix Concrete at Elko for local use in structural concrete. White quartz was quarried near Jiggs for use as building stone and exposed concrete aggregate.

Estabrook Barite Co. shipped stockpiled crude barite to a California grinder. The company's Marvel claims north of Carlin were idle in 1963. Baroid Division, National Lead Co., worked its Rossi barite mine and shipped the mineral to a company grinding plant and a custom grinder, both in California.

Lead ore from the Delno mine, Delano district, and lead-zinc ore from the Eagle mine, Merrimac district, were shipped to smelters outside the State for recovery of silver, lead, and zinc. The Delno ore also contained recoverable gold and copper. In the Tuscarora district, gold ore from the King (Wakefield Group) property was treated to recover gold and silver; gold was recovered from ore mined in 1962 at the Mystery claims; and Dale R. Gilliam was conducting work at the Aura Queen mine in an attempt to develop a gold orebody.

Esmeralda.—Great Lakes Carbon Corp. worked its diatomite deposit at Basalt and produced grades of material by air separation to meet the specifications of paper, paint, and insecticide manufacturers. The State's entire talc and soapstone production came from deposits in Esmeralda County. Four talc mines and one soapstone property yielded the entire output, all of which was consigned to California grinders.

Silver ore from the Evergreen mine northwest of Dyer was shipped to the Selby, Calif., smelter for recovery of silver. Tonopah Chemical and Silver Co. retreated old tailings at Millers Flat and recovered several hundred ounces of silver and some gold. Cleanup operations at a mill in Silver Peak yielded material from which much silver and gold were recovered at a Utah smelter. Gold also was recovered from material classified as cleanup material shipped from Millers Station to the Selby smelter in California. Mid-Continent Uranium Co. was exploring and developing the Sixteen to One gold-silver property and adjacent claims near Silver Peak. Underground exploration was begun in July at the Wonder gold claims, Goldfield district, by Goldfield Metals Production Corp. At yearend a mill was under construction. A small quantity of mercury was recovered in furnacing ore from the Poor Boy (Red Rock) mercury mine in Fish Lake Valley.

Highway maintenance crews obtained over 5,000 tons of sand and gravel from county pits for use in repairing county roads. Silicates Corp. mined bentonite from the Blanco pit near Mina and sold the mineral to a California paint manufacturer. Perlex Corp., owner of the Perlex perlite property in Fish Lake Valley, was conducting development work in anticipation of future production.

Eureka.—Nevada-Barth Mining Corp. worked the Barth iron mine near Carlin and shipped hematite ore for export. Mine production was virtually unchanged from that of 1962.

State and county highway crews produced sand and gravel at various locations for use in road maintenance and repair. Over 140,000 tons of gravel was used by an Idaho contractor in constructing a section of Interstate Route 80 in the Dunphy area.

The Mountain View zinc mine in the Lone Mountain district was the only underground metal mine in production during 1963. M.I.A. Mines Co. shipped ore from the mine to a Utah smelter for recovery of zinc, lead, and silver. The Blue Star gold mine near Dunphy was under exploration and development by Sierra del Oro, Inc., during the latter part of the year.

Humboldt.—The Getchell gold mine and new treatment plant, Potosi district, were operated uninterruptedly throughout the year by The Goldfield Corp. (formerly Getchell Mine, Inc.) and shipped bullion to the Selby smelter in California. Much of Nevada's lode gold output was credited to this operation. Gold ore from the Alabama mine in the Awakening district was treated to recover a few ounces of gold and silver. Owners of the Golden Amethyst mine near Winnemucca explored for gold ores during 1963. Old tailings were worked at the Douglas placer claims northwest of Black Horse to recover several ounces of gold and silver.

Over 96 percent of the mercury production and 95 percent of the shipments were from ore mined and furnaced at the Cordero mine, McDermitt district. About 2,700 fewer flasks were shipped despite higher averages for grade of ore mined and treated, and market value of the mercury produced. Mercury ores from the Cahill and Finnell properties were retorted to recover comparatively small quantities of the metal. The Iron King underground mine, Jackson Mountain area, was operated by Jackson Mountain Mining Co. throughout the year and shipments of magnetite ore were made to both domestic and foreign steel plants. Shipments were only slightly below 1962 figures.

Large tonnages of sand and gravel were produced by contractors for use on Interstate Route 80 between Golconda Summit and Valmy and on U.S. Highway 95 north of Orovada. At Winnemucca, building sand and gravel was prepared by John Etchart. State and county crews obtained nearly 15,000 tons of sand and gravel from various pits and used the materials in road maintenance and repair. Wegman Bros., Contractors, produced dimension building stone from a sandstone quarry near Virgin Valley. The Horton barite claims near Golconda were worked for crude barite shipped to a California grinder. The Little Britches barite claims in the same area were idle throughout the year. Sulfur ore, produced for out-of-State agricultural use, from the Crofoot property near Sulphur was only a few tons less than in 1962.

Lander.—Magnet Cove Barium Corp. mined crude barite from its Greystone property and adjoining claims and operated a grinding plant at Battle Mountain. The ground product was shipped to company facilities in Texas. FMC Corp. worked its Mountain Springs mine and shipped crude barite to the company chemical plant at Modesto, Calif. The Clipper Barite property near Battle Mountain was operated by Hullinger and Elquist, which shipped the crude mineral to grinders in California. D. A. Mining Co. mined barite from a deposit near Argenta and consigned it to a grinding company in the San Francisco Bay area. Yuba Minerals & Milling Co. stockpiled barite that was mined from its Yuba No. 1 claim at Argenta. The Milwhite and Shelton barite properties were idle in 1963, but the Shelton properties shipped some stockpiled material to a California grinder. Public works crews and contractors obtained sand and gravel from county pits and used it in road maintenance and repair.

ARD Equipment Co., Inc., mined the Hancock and McCoy iron deposits, McCoy district, for direct-shipping magnetite ores that were exported to Japan. Old tailings shipped from the Galena lead property near Battle Mountain to the Selby smelter in California contained appreciable quantities of recoverable silver, gold, lead, and zinc. Copper ore from the Copper Canyon mine, Battle Mountain district, was smelted in Tacoma, Wash., to recover copper, lead, and silver. Gold ores from the New Pass mine northwest of Austin and the McCoy mine in Horseshoe Basin were treated to recover gold and silver. Stream gravels at the Dahl placers were worked with small-scale hand equipment for placer gold and silver. In the Austin area, Apex Uranium, Inc., shipped uranium ore from its Early Day mine to a Utah processing plant and explored its Rundberg mine for uranium.

Lincoln.—Combined Metals Reduction Co. worked the Hollinger perlite deposit near Pioche. The crude material was shipped to out-of-State customers except for a relatively small tonnage sold to a Las Vegas, Nev., block plant. R. D. Wilkin shipped crude perlite from the Mackie deposit near Caliente to a California expanding plant. Stockpiled perlite from the Pearl Hill quarry near Lovelock was shipped to the Washoe County wallboard plant of U.S. Gypsum Co. The Carp fluorspar mine was idle in 1963, but the owner, Wells Cargo, Inc., shipped from stockpile to a California steel plant. The company reported assessment work only at its Tule Valley gypsum deposit southwest of Carp.

R. D. Wilkin mined sand and gravel from a pit near Pioche and prepared it in a stationary plant for use in public work projects. Various sand and gravel pits were worked by highway maintenance crews for materials needed in road repair. About 125 cubic yards of stone was quarried for riprap in a construction project on U.S. Highway 93 near Alamo. Pearl Spar, Inc., quarried white marble near Pioche and shipped it for use in building (facings) construction in Las Vegas, Nev. Diatomite, produced from the Robin claims near Panaca, was shipped to Waukena, Calif., and Maryville, Mo., where customers prepared the material for use as a soil conditioner and as a filler in livestock and poultry feeds.

Copper ore from the Bristol mine, Jack Rabbit district, and lead-silver ore produced at the Tempiute property, Tempiute district, were

747-416—64——46

processed at the Tooele, Utah, smelter to recover silver, lead, and zinc. The Bristol and Tempiute ores contained recoverable gold, and the Bristol ore yielded all the county's recoverable copper.

Lyon.—Production of The Anaconda Company copper (oxide) leaching plant and copper (sulfide) concentrator at Weed Heights was at capacity throughout 1963. Capacity at the concentrator was increased during the year. Plant products (precipitates and concentrates) were shipped to the company smelter in Montana. Gold ore mined at the Kids prospect, Pine Grove district, and dump material from two gold properties, Yerington district, were treated to recover gold and silver. Cleanup operations at the Donovan mill and two former silver mines in the Silver City area, yielded recoverable gold and silver. Byproduct recovery of placer gold and silver was reported by Dayton Sand and Gravel Co.

Dayton Sand and Gravel Co. and Carson Ready Mix worked gravel deposits in the Dayton area for concrete aggregate. Large quantities of sand and gravel were produced and prepared by Silver State Construction Co., Inc., for use on Interstate Route 80 between Wadsworth and Fernley and on U.S. Highway 95 (Alternate) between Silver Springs and Fernley. Diatomite mined in Churchill County was crushed, dried, and bagged by Aquafil Co. in a Fernley plant and shipped to customers outside the State for insulation and filler use. Fuller's earth was mined from the Jupiter pit, near Weeks, and sold for use in pelletizing, as a filtering and clarifying agent, and for various other uses.

Nevada's first cement plant was under construction by Nevada Cement Co., between Fernley and Wadsworth, at yearend. The facility will be located principally in Lyon County, on the Lyon-Washoe County line. The $15 million plant will have an annual capacity of 1.2 million barrels of cement. Expected completion date was July 1964.

Mineral.—Two barite deposits were active in 1963. Crude ore from the Columbus (Noquez) mine was shipped to a Terminal Island, Calif., grinder, and crude ore mined at the Jackson deposit near Hawthorne was consigned to a grinder at Sutter, Calif. Sand and gravel production was produced by highway crews for road maintenance. Near Luning, Sonora Marble Aggregate Co. quarried and prepared an appreciably larger tonnange of marble for terrazzo than in 1962. Diatomite was mined at the King claims, Cedar Mountain district, and prepared for filler use in a Laws, Calif., plant before shipment to customers outside Nevada. Industrial Minerals and Chemical Co. mined bentonite on the Montgomery claims near Hawthorne. The mineral was shipped to the producer's California plant where it was prepared for use as a sealant for water reservoirs and canals. Pumice from the Pumco Aggregate pit near Mina was used locally for lightweight concrete aggregate.

The Broken Hills mine, near Gabbs, and the Springer prospect, near Hawthorne, each yielded silver that was recovered at smelters in Utah and California, respectively. Both ores contained recoverable lead and the Broken Hills ore also had recoverable zinc. Federal Resources, Inc., owner of the Simon mine near Simon, was conducting an exploration and development program at the property late in the

year. Near Rawhide, Nevada Scheelite Division, Kennametal, Inc., operated its tungsten carbide plant on company stockpiled scheelite and concentrates purchase from Nevada and out-of-State producers.

Nye.—The Eagle Springs oilfield, Nevada's only producing field, was the scene of drilling in 1963. Last in the year, Texota Oil Co., on a farm-out from Shell Oil Co., completed a well that extended the existing field. The operator planned a second well south of the first that was expected to be completed early in 1964.

Basic, Inc., was the State's sole producer of magnesite. Most of the output was processed in company facilities at Gabbs, Nev., and in other States for use in making refractories. The company shipped less crude magnesite than in 1962. Basic, Inc., also made brucite shipments from stockpile, since the company reported no production for the second year. Brucite shipments increased over those in 1962. Metallurgical grade fluorspar was mined from the Crowell mine near Beatty and shipped to a California steel company. Mine-run fluorspar produced at the nearby Goldspar mine was shipped to the producer's Monolith, Calif., cement plant. Production at the Goldspar property was appreciably below that of 1962.

Government crews and contractors worked various sand and gravel deposits for materials needed in highway structures and paving. Calcareous marl was quarried at the Silimagi deposit for use as a filler in livestock and poultry feeds. Cind R Lite Co. hauled volcanic cinder from a cinder cone deposit near Beatty to the producer's block plant in Las Vegas for use as lightweight aggregate. Bentonite was dug from the New Discovery pit and from Lovelite claims near Beatty and was used in making cosmetic and pharmaceutical preparations in Las Vegas, Nev., and in California. Development and construction was underway at the Ash Meadows clay deposit of K-B Mining Corp.

L.D.C. Mining Co. furnaced cinnabar ore mined at the Ione deposit, Union district, to recover mercury, and did considerable mine development. Lesser quantities of the metal were recovered by retorting ores at the Jane mine, Union district, and the A&B mine, Tybo district, and dump material at the Yellow Cat property, Union district. All production and stocks held at the Red Bird mine, Antelope district, were shipped. Gold-silver ore produced at the Richmond mine, Union district, yielded some gold and silver. Gold was recovered by treating old tailings at the Blue Bell property, Manhattan district. Dump material at an old lead-zinc property in the Quartz Mountain district containing recoverable gold, silver, copper, lead, and zinc was shipped to Selby, Calif. Cleanup operations at the Shoe mine, Troy district, recovered a few ounces of gold and silver. In September, Heavy Aggregates, Inc., began construction of a plant to treat old tailings and slag dumps at the Tybo mine, Tybo district. At the Nevada Porphyry property near Round Mountain bench gravels and old placer tailings were treated to recover placer gold and silver. Development was conducted by the owners during most of the year. Cleanup of the dredge, formerly operated by Round Mountain Gold Dredging Corp., yielded gold and silver. Prospectors worked various stream gravel deposits and recovered placer gold and silver by small-scale hand methods. The owner of the Silvermonial

mine near Arrowhead was exploring for antimony-silver ores and had completed considerable development by yearend. The Anaconda Company continued a drilling program on the Hall molybdenum property, Manhattan district, that was begun 2 years earlier.

Hubert Welch worked his tungsten prospect in the Gabbs area and shipped some scheelite concentrate to a California ammonium paratungstate plant. The Phelps Stokes (Iron Mountain) property of Standard Slag Co. was idle.

Ormsby.—Sand and gravel deposits along the Carson River were worked by Savage Construction Co. and others for material used as concrete aggregate in local building and paving projects. Public works crews also mined sand and gravel for use in the repair and maintenance of streets and roads. L. A. Winters obtained volcanic cinder (scoria) from the Cinderlite deposit near the Carson City airport and used the material for lightweight concrete aggregate. The Strong barite deposit in the Brunswick Canyon area was idle.

Pershing.—Diatomite was mined by open pit at the Tunnel Hill property, Velvet district, by Eagle-Picher Co. and processed in the company plant at Colado. The plant product was high-purity material sold principally for filtration purposes. Crude gypsum was quarried at Empire by U.S. Gypsum Co. to supply its wallboard plant near Gerlach, Washoe County. The company plant also used previously mined perlite hauled from stockpile at the Pearl Hill quarry near Lovelock. Sand and gravel was obtained from various pits, particularly in the Lovelock area, for use in local building construction and highway maintenance.

Only two producers mined and shipped iron ore in 1963. Nevada-Barth Corp. worked the Southern Pacific lease in Section 15 and was Nevada's major producer of direct shipping iron ore. All shipments were consigned for export. Nevada Iron Ore Co., Inc., mined its iron deposit in Section 32. The ore was put over a magnetic pulley and magnetic fraction shipped to a California steel plant. A few flasks of mercury were retorted from ore produced at the Eastern group of claims and at the Darrah property, northeast of Lovelock. The mercury was sold to a San Francisco, Calif., buyer.

Lead ore produced at the Good View mine, Wild Horse district, was shipped to a Utah smelter to recover gold, silver, lead, and zinc. In the Rochester district, silver ore from the Wabash mine, containing recoverable silver, copper, lead, and zinc, was shipped to the Selby, Calif., smelter, and a small tonnage of gold ore produced at the Kings Ransom mine was treated to recover gold and silver. The Crown Point mine, near Rochester, was explored by the owner, Silver State Consolidated Mines, Co., in an effort to find sufficient minable gold and silver ore to support a milling operation. The Fidelity mine, Spring Valley, yielded some gold ore from which gold and silver were recovered. Three placer properties were worked in 1963. Stream gravels were washed by small-scale hand methods at the Barrel Springs property, Rabbit Hole district, and at the 3 Generations claims, Trinity district. Considerable gold and some silver were recovered. Stream and ancient riverbed gravels were worked by dragline at the Willow Creek placer operation, Willow Creek district. Nearly 600 ounces of gold and more than 100 ounces of silver were

recovered. Placer gold and silver also were recovered by itinerant prospectors (snipers) who washed stream gravels at many locations in the county.

Storey.—About one-third of Nevada's diatomite output was produced at the Eagle-Picher Co., Celatom open pit mine. The material was processed in the nearby Clark Station plant. The plant product was a lower grade material than that from the company's Pershing County operation. Shipments were made to both domestic and foreign customers for various industrial uses. Naturalite Co. produced lightweight concrete aggregate and decorative building stone (cut block) at its pumice claims near the Dayton County line.

Carl Boegle mined and treated a small tonnage of gold ore at the Tarto property near Gold Hill and reworked old tailings at the Fisher mill site, Comstock district, to recover gold and silver.

Washoe.—Building and street projects in the Reno-Sparks area and road construction near Pyramid Lake and on Interstate Route 80 near Wadsworth required larger tonnages of sand and gravel than in 1962. Over 2 million tons was produced from deposits along the Truckee River and adjacent stream beds and from alluvial deposits. Public works crews also produced substantially larger quantities of sand and gravel for road maintenance and repair. Stone was quarried for flood damage repair at highway bridges southwest of Wadsworth. Calcareous marl, quarried at the Double Check deposit near Flanigan, was shipped for use as a filler in animal feeds and for agricultural purposes. Fire clay and miscellaneous clay from the Faith-Geiger pits, near Steamboat Springs, were used by Reno Press Brick Co. to make brick and heavy clay products. At yearend the company closed all mining and manufacturing operations. U.S. Gypsum Co. produced plaster and wallboard in its plant near Gerlach using gypsum from its nearby quarry, Pershing County, and perlite from the Pearl Hill quarry, Pershing.

In the Olinghouse district, gold ores from the Sunbeam mine and Texas claims were treated to recover gold and silver, and ancient riverbed gravels on the Cabin placer ground were worked by dragline for recoverable gold and silver. Exploration and development for gold ore was in progress at the Olinghouse mine, near Sutcliffe, by Green Hill Development Co., owners of the property.

White Pine.—In the Robinson district, copper ores mined from the Liberty pit and taken from the Veteran pit stockpile, were treated in the Kennecott Copper Corp. McGill concentrator and smelter. Much of the State's gold, silver, and copper and all of its molybdenum was recovered in the treatment of these ores. Hamilton Corp. mined and shipped lead ore from the Hamilton (Onetha) mine, White Pine district, to the Tooele, Utah, smelter for recovery of gold, silver, copper, lead, and zinc. Silver ore, containing recoverable silver and copper, from the Pine Nut property, Cherry Creek district, was shipped to the same Utah smelter. No ore was shipped from the Silver King mine, Ward district, but the owner was nearing construction on a mill at East Ely that would process silver ores from this mine and company properties in the Taylor district. Sam Bida acquired about 200 claims (4,000 acres) west of, and adjacent to, Kennecott's Veteran pit but no activity had been reported by yearend.

Comparatively large tonnages of sand and gravel were produced by public works crews to complete road construction projects in the Connors Pass, Ely, and Strawberry areas. Buck's Supply Co. operated a stationary plant, and Angelo T. Reck operated a portable plant near Ely to supply local requirements for aggregate. Quartzite was produced at the Star Dust quarry near Baker and shipped to Nevada and Utah customers for use as dimension building stone and flagging.

The Mineral Industry of New Hampshire

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the New Hampshire Department of Resources and Economic Development for collecting information on all minerals except fuels.

By Stanley A. Feitler [1]

VALUE of New Hampshire's mineral production in 1963 was $6.2 million, exceeding that of 1962 by 2 percent and establishing a new record for the State. Increases in the value of sand and gravel, stone, clays, and feldspar offset the reduction in value resulting from cessation of mica and beryl mining. As measured by value, 98 percent of the mineral output was used in highway and building construction.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 1.—Mineral production in New Hampshire [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate ---- short tons	7	$4	----	----
Clays ---- do	37,115	37	109,875	$103
Mica:				
Sheet ---- pounds	[2] 37,508	[2] 396	----	----
Scrap ---- short tons	411	11	----	----
Sand and gravel ---- do	8,260,453	4,119	7,581,026	4,376
Stone ---- do	154,389	1,368	137,258	1,566
Value of items that cannot be disclosed: Feldspar and gem stones	----	97	----	109
Total	----	[2] 6,032	----	6,154

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Revised figure.

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$2,209	1958	$3,938
1953	2,041	1959	4,625
1954	2,276	1960	5,450
1955	2,247	1961	5,426
1956	2,690	1962	6,011
1957	3,384	1963	6,200

TABLE 3.—Water use by the mineral industry in 1962

(Million gallons)

	New water	Water recirculated	Total water used	Water discharged	Water consumed
Type of operation:					
Quarries and mills	12	----	12	10	2
Sand and gravel mines	632	429	1,061	599	33
Total	644	429	1,073	609	35
County:					
Belknap	50	----	50	47	3
Cheshire	205	----	205	191	14
Coos	54	----	54	51	3
Grafton	95	19	114	91	4
Hillsboro	70	----	70	66	4
Merrimack	61	60	121	59	2
Rockingham	61	350	411	59	2
Strafford	48	----	48	45	3
Total	644	429	1,073	609	35

Water.—The adequacy of the Nation's present and future water supply has become a problem of growing concern. A Bureau of Mines canvass of the mineral industry was made in 1963 to obtain data on the use of water in 1962. This information for New Hampshire has been presented by type of operation and by county in table 3. Most new water (96 percent) was used without treatment; the remainder was settled before use. All recirculated water was settled before being reused. Prior to discharge, 66 percent of the water was settled, 16 percent was filtered, and the remaining 18 percent was discharged without treatment. Fifty-nine percent of the water disposal was to streams and lakes; 32 percent to surface seepage; and 9 percent to sewers. For quarries and mills 8.6 gallons of new water was required per dollar of mineral production, and for sand and gravel operations 153.4 gallons was required per dollar.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—Miscellaneous clay was recovered from pits operated in conjunction with brickyards in Grafton, Rockingham, and Strafford Counties. Production was greater than in 1962, but most of the increase reflected improved response to the industry canvass.

Feldspar.—Quantity and value of usable crude feldspar were 6 percent and 15 percent higher, respectively, than in 1962. Ore from pegmatites in Cheshire and Sullivan Counties was beneficiated and ground at the Golding Keene Co. Alstead mill. Hand-sorted feldspar mined in Grafton County was shipped by truck to a grinding mill at West Paris, Maine. The output was finely ground for use in pottery, glass, enamel, and cleaning compounds. Principal States of destination for ground feldspar were New York, Ohio, Connecticut, and Massachusetts.

Gem Stones.—The value of recovered gem stones and mineral specimens was virtually unchanged in 1963. Most of the value was in mineral specimens obtained by amateur collectors from pegmatites in Grafton, Carroll, Cheshire, and Sullivan Counties. Fine euhedral, smoky quartz crystals were recovered from vugs in granite at the Red Stone quarry near Conway in Carroll County.

Mica.—No mine production of either sheet or scrap mica was reported during the year.

Sales of wet ground mica increased moderately, but the average value was lower than in 1962. The finely ground product was used principally for wallpaper, paint, and rubber. Most of the scrap mica for mill feed was imported from India and South Africa.

Sand and Gravel.—The tonnage of sand and gravel produced in 1963 decreased 8 percent from that of 1962, but the total value increased 6 percent. Average value per ton increased 16 percent to $0.58. Commercially produced sand and gravel was higher in both quantity and value, but the average value per ton was $0.89, a decrease of $0.07 from that of 1962. The quantity of sand and gravel used for building increased 28 percent to 1.2 million tons. All Government-and-contractor and 64 percent of the commercially produced material was used for highway construction, fill, and other nonbuilding purposes. Minor quantities were sold for furnace and engine sand.

Trainloads of washed and screened sand and gravel for use in concrete were shipped to the Boston, Mass., area from a commercial plant in Merrimack County. Trainload shipments of bank run sand and gravel were produced from a pit in Strafford County for use in a large fill in the Massachusetts turnpike east extension. The fill was completed and the operation was discontinued during 1963. Crews of the Concord Commissioner of Public Works, Merrimack County, produced sand and gravel for highway construction and maintenance.

Stone.—Output of stone decreased 11 percent in tonnage and increased 14 percent in value. Dimension stone, which was produced at the Kitledge quarry in Hillsboro County and the Swenson Gray quarry in Merrimack County for dressed architectural stone, curbing, and monumental stone, accounted for most of the value. Quarry blocks from these and other quarries were processed at nearby finishing plants. Granite quarried for riprap and fill was produced in all except Strafford and Sullivan Counties by the New Hampshire Department of Public Works and Highways. Miscellaneous stone mined in Rockingham County was used for riprap, concrete aggregate, and roadstone. Crushed quartz for use as exposed aggregate was mined at two localities in Sullivan County and one in Hillsboro County.

TABLE 4.—Sand and gravel, and stone production by Government-and-contractor operations, by counties

(Short tons)

County	Sand and gravel		Stone	
	1962	1963	1962	1963
Belknap	45,881	86,214	----------	272
Carroll	198,869	26,057	18,459	1,315
Cheshire	158,034	153,820	2,947	1,664
Coos	483,003	1,328	10,848	3,074
Grafton	342,255	100,697	5,818	33,972
Hillsboro	399,736	737,614	----------	743
Merrimack	1,222,929	(1)	10,087	3,311
Rockingham	540,420	340,907	358	297
Strafford	1,637,719	(1)	----------	----------
Sullivan	159,431	82,388	983	----------
Unspecified	677,700	2,849,929	----------	----------
Total	5,865,977	4,378,954	49,500	44,648

[1] Figure withheld to avoid disclosing individual company confidential data; included in "Unspecified."

REVIEW BY COUNTIES

Sand and gravel and stone produced by Government-and-contractor operations are shown by county in table 4 and are not included under the individual county reports that follow.

TABLE 5.—Value of mineral production in New Hampshire, by counties

County	1962	1963	Minerals produced in 1963 in order of value
Belknap	(1)	(1)	Sand and gravel, stone.
Carroll	(1)	(1)	Sand and gravel, gem stones.
Cheshire	$595,912	$448,027	Sand and gravel, feldspar, stone, gem stones.
Coos	(1)	(1)	Sand and gravel, stone.
Grafton	[2] 697,439	435,833	Sand and gravel, stone, clays, feldspar, gem stones.
Hillsboro	1,165,333	1,468,856	Stone, sand and gravel.
Merrimack	1,535,736	1,084,586	Sand and gravel, stone.
Rockingham	449,095	953,118	Sand and gravel, stone, clays.
Strafford	(1)	332,929	Sand and gravel, clays.
Sullivan	120,513	135,387	Sand and gravel, feldspar, stone, gem stones.
Undistributed [3]	1,468,432	1,295,588	
Total	[2] 6,032,000	6,154,000	

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Revised figure.
[3] Includes value of sand and gravel, gem stones, mica (1962), and beryllium (1962) not assigned to specific counties and values indicated by footnote 1.

Belknap.—Building and paving sand and gravel and sand for fill were produced by Tilton Sand & Gravel, Inc., Tilton.

Carroll.—Paving gravel and sand and gravel for fill were produced at Conway and Ossipee.

Cheshire.—Sand and gravel for building, paving, and fill was produced by Cold River Sand & Gravel Corp., North Walpole, and Keene Sand & Gravel, Inc., Keene. Crude mixed feldspar recovered at the Turner, Salo, and Windham mines by Golding-Keene Co. was delivered by truck to the company's nearby Alstead mill. The crude feldspar was beneficiated and ground for use in manufacturing insulators, enamel, floor tile, and pottery. Part of the output was used as an abrasive in cleaning compounds. Gem and mineral specimens were recovered from pegmatite mine dumps.

Coos.—Building and paving sand and gravel was recovered near Gorham by Lessard Sand & Gravel Co. The Gray Construction Co., Colebrook, and Brown Co., Berlin, produced sand and gravel for road construction and fill.

Grafton.—Sand and gravel produced from pits near West Campton, Littleton, Lebanon, West Lebanon, and Plymouth was used mainly for building, paving, and fill. Miscellaneous clay recovered from an open pit mine by Densmore Brick Co., Lebanon, was used for making building brick. Crude potash feldspar produced at the Ruggles mine was shipped to a grinding mill at West Paris, Oxford County, Maine. Ruggles mine dumps were available to mineral collectors for an admission fee. A wide variety of pegmatite minerals were recovered at the Ruggles and other mine dumps in Grafton County. Thermal Dynamics Corp., Lebanon, produced spheroidized particles of refractory metals, oxides, nitrides, and carbides by use of a plasma flame. Reactive materials were processed in controlled atmospheres.

Hillsboro.—Commercial sand and gravel used chiefly for building and paving was produced by Robie Construction Co., Inc., and J. J. Cronin, both near Manchester; Merrimack Sand & Gravel Corp., Merrimack; and The Harris Construction Co., Inc., Peterborough.

Hillsboro County ranked first among the stone-producing counties. Quarry blocks of granite mined at the Kitledge quarry near Milford were cut and finished at the Baretto Granite Co. mill. The stone was sold chiefly for use as curbing, dressed architectural stone, and monuments. The Minerals Material, Inc., produced and crushed quartz for exposed aggregate at the Lyndeboro quarry.

Merrimack.—Manchester Sand, Gravel & Cement Co., Inc., Hooksett, produced sand and gravel chiefly for building and paving. The John Swenson Granite Co., Inc., Concord, quarried granite at the Swenson Gray quarry and produced dressed architectural stone and curbing at its nearby finishing mill. Blocks quarried in Maine and Vermont also were finished at Swenson's Concord mill.

Rockingham.—The county was the leading commercial sand and gravel producing area in the State. Sand and gravel chiefly for fill was produced by Thomopoulis Sand & Gravel Pit near Londonderry, and L. Chester & C. W. Simpson, Exeter. Manchester Sand, Gravel & Cement Co., Inc., Raymond, produced building and paving sand and gravel. Most of the output of the Raymond plant was shipped by railroad to Boston, Mass., for use in ready-mixed concrete. Iafolla Crushed Stone Co., Inc., Portsmouth, produced sand and gravel for road maintenance and repairs, and sand for fill.

Eno Brick Corp., Exeter, and W. S. Goodrich, Inc., Epping, mined miscellaneous clay for use in manufacturing building brick. Iafolla Crushed Stone Co., Inc., Portsmouth, quarried and crushed miscellaneous stone for use as concrete aggregate, roadstone, and riprap.

Strafford.—Dover Sand & Gravel, Inc., Dover, produced building sand and gravel. James S. Pike, Durham, produced bank run sand and gravel. Iafolla Crushed Stone Co., Inc., Madbury, produced sand and gravel for road maintenance and repairs, and gravel for fill. The Kane-Gonic Brick Corp., Gonic, mined miscellaneous clay for manufacturing building brick.

Sullivan.—Building sand and paving sand and gravel were produced near Newport by Eaton Jones Sand & Gravel Co., Inc. Golding-Keene Co. mined crude mixed feldspar at the Yuhas mine near Acworth, and the Sargent mine. The output was trucked to the company-owned grinding mill at Alstead, Cheshire County. Crushed quartz for exposed aggregate was produced at Beryl Mountain, South Acworth, by Quartz, Inc., and at the Glove quarry near New London by The Minerals Material, Inc.

The Mineral Industry of New Jersey

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the New Jersey Division of Resource Development, Bureau of Geology and Topography, for collecting information on all minerals except fuels.

By Charles C. Yeloushan [1]

VALUE of mineral production totaled $73.3 million, a 12 percent increase over that of 1962, establishing a new high for the second consecutive year. The $7.6 million increase was attributed to greater production of sand and gravel, zinc, ilmenite, and magnesium compounds. Decreases in total value were reported for stone, clays, peat, iron ore, lime, and manganiferous residuum.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the

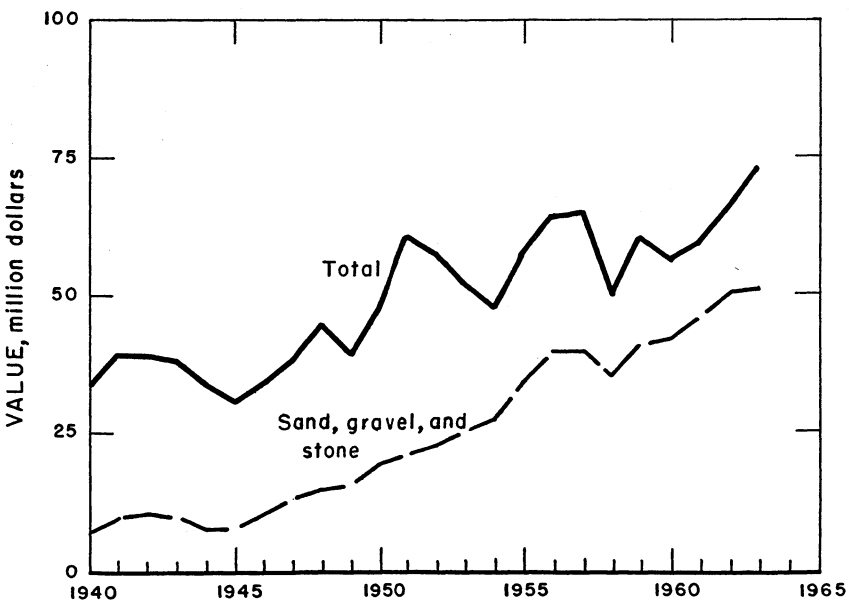


FIGURE 1.—Value of sand, gravel, and stone, and total value of mineral production in New Jersey, 1940–63.

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 1.—Mineral production in New Jersey[1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	584	$1,476	498	$1,392
Gemstones	(2)	9	(2)	9
Peat short tons	29,099	247	23,685	241
Sand and gravel thousand short tons	13,728	21,230	16,672	25,245
Stone do	14,214	28,979	11,229	25,654
Zinc[3] (recoverable content of ores, etc.) short tons	15,309	3,559	32,738	7,855
Value of items that cannot be disclosed: Iron ore, lime, magnesium compounds, manganiferous residuum, greensand marl, titanium concentrate (ilmenite)		10,186		12,880
Total		65,686		73,276

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Recoverable zinc valued at the yearly average price of prime western slab zinc, East St. Louis market. Represents value established after transportation, smelting, and manufacturing charges have been added to the value of ore at the mine.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$63,749	1958	$50,640
1953	56,555	1959	58,291
1954	50,003	1960	55,917
1955	60,519	1961	58,857
1956	64,748	1962	65,358
1957	65,499	1963	71,977

Employment and Injuries.—Preliminary data indicate a 12-percent increase in total man-hours worked. Increases in man-hours worked were reported in all industries except nonmetal mines. Nonfatal lost-time injuries increased 13 percent in number, but injuries per million man-hours worked increased less than 4 percent. Three fatalities were reported.

Trends and Developments.—Kaiser Gypsum Co., a subsidiary of Permanente Cement Co., planned to build a plant in Burlington County costing approximately $6 million and having an annual production capacity of 180 million square feet of gypsum board and 40,000 tons of plaster. The newest platinum-group metal refinery in the United States was completed by Spiral Metal Co., Inc., at South Amboy. A 640,000 kilowatt capacity atomic powerplant, to be built by General Electric Co. for Jersey Central Power and Light Co. at Oyster Creek in Ocean County, will be one of the larger in the U.S. New Jersey Natural Gas Co. experimented on underground storage of natural gas in the southern part of the State.

TABLE 3.—Employment and injuries in the mineral industries[1]

Industry	Men working daily	Man-hours worked	Injuries		
			Fatal	Nonfatal	Per million man-hours
1962:					
Sand and gravel	1,198	2,367,187	1	45	19
Quarries and mills	1,066	2,160,179	2	36	18
Nonmetal mines[2]	63	88,818		7	79
Metal mines and mills	541	873,205		54	62
Total	2,868	5,489,389	3	142	26
1963:[3]					
Sand and gravel	1,142	2,421,316	1	39	17
Quarries and mills	1,129	2,359,814		45	19
Nonmetal mines[2]	51	78,967		2	25
Metal mines and mills	601	1,271,953	2	74	60
Total	2,923	6,132,050	3	160	27

[1] Excludes officeworkers.
[2] Includes clays, greensand marl, and magnesium compounds.
[3] Preliminary figures.

Water.—Mineral producers in New Jersey were canvassed in 1963 for water usage in 1962. A preliminary summary of the data reported is listed in table 4. Of 155 respondents, 76 reported adequate water supply at present, 3 adequate for 5 years, 14 adequate for 10 years, and 59 adequate for 20 years. Twenty-eight respondents recirculate water and another 10 could recirculate if the need arose. New water used by the mineral industry consisted of 7.7 billion gallons of fresh water and 5.2 billion gallons of otherwise contaminated water. Of the water disposed by the mineral industry, 8.7 million gallons were discharged to sewer, 9.9 billion gallons to surface, and 2.5 billion gallons to ground.

TABLE 4.—Water use in the mineral industry in 1962

(Million gallons)

	New water	Water recirculated	Total water use	Water discharged	Water consumed	Gallons of new water per dollar value of production
Stone (quarries and mills)	79	3	82	73	6	2.76
Metal mines and mills	2,796	3,392	6,188	2,783	13	245.80
Nonmetal mines and mills	72	60	132	72	(1)	43.20
Sand and gravel	9,943	5,840	15,783	9,523	420	468.34
Total	12,890	9,295	22,185	12,451	439	204.75

[1] Less than 500,000 gallons.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—Fire and miscellaneous clay production decreased 15 percent in total tonnage and 6 percent in total value. Fire clay accounted for most of the value, but miscellaneous clay and shale contributed most of the tonnage. Fire clay was of the plastic variety and was used

mainly for manufacturing refractory products. Miscellaneous clay and shale was used principally for manufacturing building brick and other heavy clay products. Fire clay was produced in Cumberland and Middlesex Counties, and miscellaneous clay and shale was produced chiefly in Middlesex and Somerset Counties with small production coming from Bergen, Burlington, and Camden Counties. Clay production was reported from 18 operations, compared with 21 operations in 1962.

Gem Stones.—Various mineral specimens continued to be collected from mineral deposits and old mine dumps throughout the State. Mineral and gem enthusiasts reported collecting zeolite specimens in Passaic and Union Counties, carnelian specimens in Morris County, and calcite specimens in Sussex County.

Gypsum.—Calcined gypsum for manufacturing plaster, wallboard, sheathing, lath, and other building materials was produced at plants in Bergen and Burlington Counties.

Lime.—Hydrated lime was produced in Sussex County for construction, agricultural, and water purification purposes. Production decreased 7 percent in total tonnage and 8 percent in total value.

Magnesium Compounds.—Refractory magnesia was produced in Cape May County from raw sea water and dolomite. Production of magnesium compounds increased 58 percent in total tonnage and 55 percent in total value.

Marl, Greensand.—Production of greensand marl from Burlington and Gloucester Counties decreased 5 percent in total tonnage but increased 12 percent in total value. The operation in Burlington County produced greensand marl for soil conditioning but was closed during the year. The operation in Gloucester County produced greensand marl for water softening.

Perlite.—Crude perlite obtained from out-of-State operations was expanded at plants in Middlesex and Union Counties for use in building plaster, loose fill insulation, concrete aggregate, and soil conditioning.

Pigments.—Hydrated ferric oxide pigments were produced in Essex County. Manufactured magnetic black iron oxide (pure), brown iron oxide (pure), red iron oxide (pure), and yellow iron oxide (pure) pigments were produced in Mercer County. Manufactured red iron oxide pigments were produced in Middlesex County.

Sand and Gravel.—Sand and gravel production increased 21 percent in total tonnage and 19 percent in total value and accounted for 34 percent of the total value of mineral production in the State. Cumberland County continued to lead 13 other sand-and-gravel-producing counties in total tonnage and value. Counties contributing over $1 million of sand and gravel production to the State total were Bergen, Burlington, Camden, Cumberland, Middlesex, Morris, and Ocean. Sand and gravel used for building and paving accounted for 69 percent of the total tonnage. Ground sand production was used for abrasive, chemical, filler, glass, foundry, pottery, porcelain, tile, and other uses. Unground sand production was used for glass, molding, grinding, polishing, blast, fire or furnace, engine, filtration, and other purposes.

TABLE 5.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	4,465	$4,465	5,031	$5,309
Paving	2,534	2,000	2,995	2,539
Fill	(1)	(1)	1,526	567
Glass	683	2,595	748	2,780
Molding	1,509	4,788	1,570	5,043
Grinding and polishing	19	54	22	64
Blast	107	550	122	653
Fire or furnace	8	22	(1)	(1)
Engine	29	96	27	93
Filtration	10	51	38	141
Filler	43	369	49	392
Foundry uses	(1)	(1)	37	313
Other [2]	776	1,568	469	1,259
Total	10,183	16,558	12,634	19,153
Gravel:				
Building	1,899	2,997	2,244	4,065
Paving	1,254	1,401	1,187	1,674
Fill	271	127	430	181
Other [3]	90	135	169	169
Total	3,514	4,660	4,030	6,089
Total sand and gravel	13,697	21,218	16,664	25,242
Government-and-contractor operations:				
Sand:				
Paving	3	1	----	----
Other	5	2	4	2
Total	8	3	4	2
Gravel:				
Paving	23	9	4	1
Total sand and gravel	31	12	8	3
All operations:				
Sand	10,191	16,561	12,638	19,155
Gravel	3,537	4,669	4,034	6,090
Total	13,728	21,230	16,672	25,245

[1] Included in "Other."
[2] Includes ground and other sand and items indicated by footnote 1.
[3] Includes other and miscellaneous gravel.

Stone.—Stone production of all types decreased 21 percent in quantity and 11 percent in value from 1962 and accounted for 35 percent of the State's total value of mineral production. Basalt (traprock) was the principal stone quarried, comprising 87 percent of the total stone tonnage and 79 percent of the total stone value. Basalt was quarried and crushed in Essex, Hunterdon, Mercer, Passaic, Somerset, and Union Counties. Crushed basalt was used chiefly as concrete aggregate and roadstone, but some was used for riprap, railroad ballast, and miscellaneous purposes. Granite production was reported from four companies in Hunterdon and Morris Counties. Crushed granite was used for riprap, concrete aggregate, roadstone, and railroad ballast. Limestone was produced by two companies in Sussex County and used for concrete aggregate, roadstone, flux, agricultural purposes, whiting, asphalt filler, flooring filler, mineral food, filter

beds, fertilizer filler, poultry grit, lime, roofing spar, and white aggregate. Oystershell was recovered and ground for poultry grit and lime in Gloucester County. Marble was quarried in Warren County and crushed for use in flooring made of small chips of marble set irregularly in cement and polished. Miscellaneous stone was quarried in Hunterdon County for rough dimension building stone and in Passaic County for concrete aggregate and roadstone.

Roofing Granules.—Natural and artifically colored roofing granules were produced in Bergen, Passaic, and Somerset Counties from basalt (traprock) quarried in the State. Five companies reported production. Production of roofing granules increased less than 1 percent in total tonnage but decreased 6 percent in total value.

Sulfur.—Sulfur was recovered as a byproduct in the liquid purification of gas by various processes. Production was reported from plants in Gloucester, Middlesex, and Union Counties and totaled 48,707 long tons. Shipments totaled 47,664 tons and were valued at $1 million. Shipments of sulfur, used in manufacturing sulfuric acid and in other chemical processes, increased 5 percent.

Vermiculite.—Vermiculite was exfoliated in Essex and Mercer Counties. The product was used for insulation, concrete aggregate, plaster aggregate, and agricultural-chemical purposes. Production of exfoliated vermiculite increased 17 percent in total tonnage and 22 percent in total value.

METALS

United States Metals Refining Co. at Carteret produced copper, silver, gold, and solder. American Smelting & Refining Co. produced copper, lead, copper alloys, silver, and gold in its Perth Amboy plant at Barber. Federated Metals Division of American Smelting & Refining Co. produced copper-base alloys, lead products, and aluminum in its Perth Amboy plant at Barber; white metals, magnesium, and copper-base alloys at Newark; and zinc dust at Trenton. Aetna Smelting & Refining Works, Inc., at Jersey City produced lead, lead alloys, solder, and babbitt. Alpha Metals, Inc., at Jersey City produced solders, lead, tin, and their alloys. Kearny Smelting & Refining Corp. at Kearny produced brass and bronze ingots. Engelhard Industries, Inc., at Newark produced gold and silver in bars and silver powder. Essex Lehman Alloys Co. at Newark produced tin-lead alloys and brass and bronze ingots. Magnolia Metal Co., Inc., at Newark produced babbitt metals, bronze and bar stock, and bronze bushings. Ronson Metals Corp. at Newark produced rare-earth metals and alloy products. Emil A. Schroth, Inc., at Newark produced soft lead, solder, babbitt car boxes, white metal alloys, No. 1 copper briquets, brass tubing, and powdered cuprous oxides. Chas. P. Hull Co., Inc., at North Arlington produced solder, babbit, tin ingots, and white metal alloys. International Smelting and Refining Co. at Perth Amboy produced refined copper, cathodes, and cast shapes. National Lead Co. at Perth Amboy produced antimonial and soft lead solders, and babbitts. Howe Refining Corp. at Sewaren produced additives for aluminum, magnesium, steel, and high-temperature and vacuum-melted metals. Vulcan Detinning Division of Vulcan Materials Co. at Sewaren produced pig tin, tin anodes, and tin powder. American

Nickel Alloy Manufacturing Corp. at Weehawken produced nickel, nickel-alloys, and ferroalloys.

Iron Ore.—Magnetite ore was produced from underground mines in Morris and Warren Counties and beneficiated magnetically to an iron concentrate. Most of the concentrate was shipped by railroad to blast furnaces at Conshohocken, Pa., for steelmaking, but part was ground and sold for use in powder metallurgy. The Morris County mine reduced operations at the end of the year, and the Warren County mine was expected to be worked out soon. Iron ore concentrate, mined and beneficiated in previous years, was shipped from stockpiles in Morris County. Shipments of usable iron ore decreased 6 percent in tonnage and value.

Titanium.—Ilmenite was recovered from titanium-bearing sands in Ocean County and concentrated for shipment to Baltimore, Md., for conversion to titanium dioxide used in making white paint pigment.

Zinc.—The Sterling Hill underground mine in Sussex County operated at capacity. Crushed crude zinc ore was produced and shipped direct to smelter at Palmerton, Pa.

MINERAL FUELS

Coke and Coal Chemicals.—Coke and coal chemicals were produced from a merchant oven coke plant in Hudson County. Coal-chemical materials produced were monoammonium phosphate, crude coal tar, crude light oil, intermediate light oil, and crude naphthalene. Distribution of oven and beehive coke in New Jersey from domestic sources, based upon reports from producers showing destination and principal end use of coke used and sold, was 94,113 tons to foundries, 77,447 tons to other industrial plants, and 60,105 tons for residential heating.

Peat.—Peat produced from bogs in Sussex and Warren Counties decreased 19 percent in total tonnage and 2 percent in total value. Most of the peat was sold in bulk form for use as a soil conditioner.

Petroleum.—Seven petroleum refineries were operating in New Jersey during 1963 with a total crude capacity of 529,950 barrels per day. Daily crude capacities of individual refineries, in barrels, follows: California Oil Co. at Perth Amboy in Middlesex County, 100,000; Cities Service Oil Co. at Linden in Union County, 15,000; Hess Oil & Chemical Corp. at Sewaren in Middlesex County, 71,250; Humble Oil & Refining Co. at Bayonne in Hudson County, 16,700, and at Linden in Union County, 168,000; Socony Mobil Oil Co., Inc., at Paulsboro in Gloucester County, 79,000; and Texaco Inc. at Westville in Gloucester County, 80,000.

REVIEW BY COUNTIES

Atlantic.—Sand and gravel production from commercial and noncommercial operators increased 215 percent in total tonnage and 73 percent in total value. Ole Hansen & Sons, Inc., at Pleasantville produced sand for fill and gravel for paving purposes. Mays Landing Sand & Gravel Co., Inc., at Mays Landing and Mizpah Sand & Gravel Co. at Bargantown produced sand and gravel for building purposes. Delco Construction Co. at Hammonton produced gravel for the paving purposes of the State highway department and the town of Hammonton. Somers Point Washed Sand Co. at Somers Point produced

sand and gravel for building and miscellaneous purposes. Industrial sand for molding purposes was produced by Taggard Brimfield Co. of Hammonton at its Cedar Lake plant. Atlantic County Road Department at Pleasantville produced sand for ice control on roads and sand and gravel for patch material. Walter A. Daminger produced sand and gravel near Hammonton for bituminous mix and road gravel. Macrie's Sand & Gravel at Hammonton produced sand for building purposes. Atlantic Sand & Gravel Co. produced sand and gravel for concrete pipe at Folsom. Tri-State Sand Co. at Millville produced industrial unground sand for molding purposes.

TABLE 6.—Value of mineral production in New Jersey, by counties [1]

County	1962	1963	Minerals produced in 1963 in order of value
Atlantic	$255,357	$442,188	Sand and gravel.
Bergen	5,848,844	1,541,560	Sand and gravel, clays.
Burlington	1,455,561	2,437,066	Sand and gravel, clays, greensand marl.
Camden	1,623,093	1,787,640	Sand and gravel, clays.
Cape May	(2)	(2)	Magnesium compounds, sand and gravel.
Cumberland	8,512,685	9,215,231	Sand and gravel, clays.
Essex	(2)	(2)	Stone.
Gloucester	646,549	648,548	Sand and gravel, greensand marl, stone.
Hunterdon	[4] 1,185,659	1,132,439	Stone.
Mercer	(2)	(2)	Do.
Middlesex	2,380,096	2,424,917	Sand and gravel, clays.
Monmouth	767,619	940,966	Sand and gravel.
Morris	9,735,648	10,251,882	Iron ore, sand and gravel, stone, gem stones.
Ocean	1,821,931	4,308,562	Ilmenite, sand and gravel.
Passaic	5,704,998	6,358,909	Stone, sand and gravel, gem stones.
Somerset	11,460,768	11,543,809	Stone, clays.
Sussex	7,571,430	11,996,866	Zinc, stone, sand and gravel, lime manganiferous residuum, peat, gem stones.
Union	(2)	(2)	Stone, gem stones.
Warren	1,732,429	1,947,677	Iron ore, sand and gravel, stone, peat.
Undistributed [3]	[4] 4,983,393	6,297,714	
Total	65,686,000	73,276,000	

[1] No production reported in Hudson and Salem Counties.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes value of gem stones, and sand and gravel not assigned to specific counties and values indicated by footnote 2.
[4] Revised figure.

Bergen.—Sand and gravel production increased 3 percent in total tonnage and 15 percent in total value. Braen Sand & Gravel Co. at Wyckoff produced sand and gravel for building and paving purposes. McKee Bros., Inc., at Ramsey produced sand and gravel for building purposes and sand for ice control on State and county roads. Samuel Braen & Co. at Mahwah produced sand and gravel for construction purposes. Miscellaneous clay was mined by Tri-County Brick Corp. near Moonachie for manufacturing building brick. Calcined gypsum was produced by Allied Chemical Corp. at its South Kearney plant.

Burlington.—Sand and gravel production increased 54 percent in total tonnage and 71 percent in total value. Amico Sand & Gravel Co. from two dredging operations at Riverside produced sand and gravel for building, paving, snow removal, and fill. Asphtar, Inc., at Hainesport produced unprocessed sand for paving purposes. George F. Pettinos, Inc., at Mount Holly produced unprocessed sand for paving and molding purposes. Lockhart, Inc., at Riverton produced sand for building and paving purposes and gravel for paving

purposes. American Dredging Co. produced sand and gravel from a dredging operation for building and paving purposes. Warner Co. produced sand and gravel from its Franklin dredge for ready-mixed concrete and building purposes. H. R. Sherman produced sand for building purposes at Burlington. Miscellaneous clay was mined by Church Brick Co. near Bordentown for manufacturing building brick. Greensand marl was produced for use as a soil conditioner by National Soil Conservation, Inc., at Medford, but the operation was closed in September. Calcined gypsum was produced by National Gypsum Co. at its Burlington plant.

Camden.—Sand and gravel production decreased 6 percent in total tonnage but increased 11 percent in total value. Tri-Borough Sand & Stone, Inc., at Gibbsboro was the largest producer of sand and gravel for building, paving, and miscellaneous purposes. Con-Agg-Inc., a subsidiary of South Jersey Construction Co., produced sand for building, paving, and sanding roads and gravel for paving purposes at Chews Landing. Ward Sand and Materials Co. at Pennsauken Township produced sand for building and paving purposes. Triangle Silica Sand Co. at Pine Hill produced sand and gravel for miscellaneous uses. Molding sand for foundry uses was produced at the following operations: George F. Pettinos, Inc., at its Grenloch, Williamstown Junction, and Penbryn plants; Taggard Brimfield Co. at its Hayville plant; and William Thorn & Son at Grenloch. Miscellaneous clay was mined by The Alliance Clay Product Co. near Winslow Junction for manufacturing building brick.

Cape May.—Northwest Magnesite Co. produced refractory magnesia from a combination of raw sea water and dolomite at its Cape May plant. Sand and gravel production increased 18 percent in total tonnage and 28 percent in total value. Tuckahoe Sand & Gravel produced sand and gravel for building purposes at Tuckahoe. John F. Gandy produced sand and gravel for paving purposes at Marmora. Matalucci Brothers produced sand and gravel for building and paving purposes at Avalon. Courtland Sand & Gravel Co. at Cape May Court House produced sand and gravel for building purposes.

Cumberland.—The county continued to lead 13 other counties in total sand and gravel value. Sand and gravel production increased 4 percent in total tonnage and 7 percent in total value. Industrial sand for molding purposes only was produced by Whitehead Brothers Co. at Dorchester Dividing Creek, New Jersey Silica Sand Co. at Millville, and Tri-State Sand Co. near Millville. Pennsylvania Glass Sand Corp. at Millville produced industrial unground sand for glass, chemical uses, tile, building products, abrasives, and engine uses; and industrial ground sand for abrasives, chemical uses, filler, foundry uses, glass, pottery, porcelain, tile, soap, and metallurgical and other purposes. National Glass Sand Corp. at Millville produced unground sand for glass, molding, and blast purposes; and ground sand for pottery, porcelain, tile, soaps, chemical, flooring, and foundry uses. Jesse S. Morie & Son, Inc., with operations at Mauricetown and Millville produced sand and gravel for building, paving, and filtration; and industrial unground sand for glass, molding, blast, furnace, engine, filtration, and miscellaneous uses. Millville Silica Sand &

Gravel Co., Inc., at Port Elizabeth produced sand for building purposes, gravel for fluxing, and industrial unground sand for molding, blast, engine, and other uses. George F. Pettinos, Inc., at Port Elizabeth produced industrial unground sand for molding, blast, and filtration uses. Port Silica Sand Co., Inc., at Port Elizabeth produced industrial unground sand for foundry and sand blast purposes. Armstrong Cork Co. at Millville produced industrial unground sand for glass manufacture. Mays Landing Sand & Gravel Co., Inc., at Cedarville and Brunetti Brothers at Vineland produced sand and gravel for building purposes. Ricci Brothers Washed Sand & Stone Co. at Port Norris produced sand and gravel for building and paving purposes. Plastic fire clay was mined by Daniel Goff, Division of Jesse S. Morie & Sons, Inc., at its Clayville plant near Millville for molding sand bond.

Essex.—Orange Quarry Co. quarried and crushed basalt (traprock) at West Orange for concrete aggregate, roadstone, screenings, and riprap. Basalt was also quarried by M. L. Kernan at South Orange and crushed for concrete and roadstone. E. I. du Pont de Nemours & Co., Inc., at Newark produced hydrated ferric oxide pigments. Vermiculite was exfoliated by Vermiculite Industrial Corp. at Port Newark for insulation, concrete aggregate, plaster aggregate, and agricultural and chemical uses.

Gloucester.—Sand and gravel production decreased 4 percent in total tonnage and 6 percent in total value. Wenonah Sand & Gravel Co. at Repaupo produced sand and gravel for building purposes. Buzby Brothers & Co., Inc., at Mount Ephraim, L. R. Curtis' Son at Bridgeport, and Crown Point Sand Co., Inc., at Gibbstown produced sand for building purposes. Downer Silica Co. at Glassboro produced unprocessed industrial unground sand for furnace use and unprocessed gravel for paving purposes. Greensand marl was produced and sold to various water-treating equipment manufacturers by Inversand Co. near Sewell. Oystershell was processed by Joseph Bauder & Sons at Franklinville for poultry grit and lime. Sulfur was recovered as a byproduct in the liquid purification of gas by the modified Baehr process by Freeport Sulphur Co. at its Eagle Point plant in Westville. Socony Mobil Oil Co., Inc., used the Claus process at their Paulsboro refinery to recover sulfur as a byproduct.

Hudson.—Koppers Co., Inc., operated a merchant oven-coke plant at Kearny. Coke and coal chemicals were produced from 55 Koppers and 65 Koppers-Becker slot ovens.

Hunterdon.—Basalt (traprock) was quarried and crushed by Houdaille Construction Materials, Inc., at Oldwick for concrete aggregate and roadstone. Diabase traprock was quarried and crushed for concrete aggregate, roadstone, and railroad ballast by Lambertville Quarry Co. at Lambertville. Granite was quarried and crushed by Anthony Ferrante & Sons near Clinton for riprap, concrete aggregate, and roadstone. Rough dimensional building stone was quarried by Delaware Quarries near Lumberville.

Mercer.—Pennington Quarry Co. quarried and crushed diabase traprock at Pennington for concrete aggregate, roadstone, riprap, and railroad ballast. Crushed traprock production for riprap was reported by the Mercer County Workhouse at Trenton. Manufactured magnetic black iron oxide (pure), brown iron oxide (pure), red iron

oxide (pure), and yellow iron oxide (pure) pigments were produced by Columbian Carbon Co. at Trenton. Exfoliated vermiculite was produced by Zonolite Co. at its Trenton plant.

Middlesex.—Sand and gravel production increased 40 percent in total tonnage and 13 percent in total value. Sayre & Fisher Co. at Sayreville produced mason sand and sand for fill. Buck Brothers, Inc., at Edison produced sand for road subbase and sandy-type fill. Herbert Sand Co., Inc., at East Brunswick produced sand for building and paving and gravel for building purposes. Crossman Co. near Sayreville produced sand for building, paving, and fill purposes and gravel for fill. Dallenbach Sand Co., Inc., at Milltown produced sand and gravel for building purposes. Raritan River Sand Co. at Nixon and Glenn-Rock Concrete Products Co. at Jamesburg produced sand for building purposes and gravel for building and fill uses. Buck Realty Co., Inc., at East Brunswick produced sand for paving purposes and site development. South River Sand Co. at Old Bridge produced sand for fill; industrial unground sand for blast, engine, filtration, and other uses; and industrial ground sand for abrasives, filler, and foundry uses. Whitehead Brothers Co. produced unground molding sand at Sayreville.

The county led five other clay-producing counties, accounting for 49 percent of the State's clay tonnage and 64 percent of the State's clay value. Clay production decreased 26 percent in total tonnage and 13 percent in total value. Miscellaneous clay was produced by Oschwald Brick Works near Cliffwood for manufacturing building brick and by Natco Corp. at Keasbey for manufacturing building brick and other heavy clay products. Sayre & Fisher Co. near Sayreville produced plastic fire clay for manufacturing firebrick and mortar and miscellaneous clay and shale for manufacturing building brick and lightweight aggregate. Valentine Fire Brick Division of A. P. Green Fire Brick Co. produced plastic fire clay at Perth Amboy for manufacturing firebrick and block and at Woodbridge for manufacturing firebrick and block and foundries, steelworks (bulk). Crossman Co. at South Amboy produced plastic fire clay for manufacturing firebrick and block and foundries, steelworks (bulk); for filler in linoleum, oilcloth, insecticides, and fungicides; and for rotary-drilling mud. Marcus S. Wright, Inc., at Milltown produced plastic fire clay for foundries, steelworks (bulk) and high-temperature cement. Almasi Clay Co. at Woodbridge produced plastic fire clay for manufacturing firebrick and block, clay crucibles, and foundries, steelworks (bulk). Clay was also produced for miscellaneous uses by McHose Clay Co. near Edison, Such Clay Co., near Sayreville, and H. C. Perrine & Son, Inc., at Matawan.

Sulfur was recovered as a byproduct by The Anlin Co. of New Jersey using the Amine gas purification and modified Claus processes at its Perth Amboy plant. Manufactured red iron oxide pigments were produced by Columbian Carbon Co. at Monmouth Junction and Stabilized Pigments, Inc., at New Brunswick. Coralux Perelite Corp. of New Jersey at Metuchen expanded crude perelite for use as building plaster, loose fill insulation, concrete aggregate, and soil conditioner.

Monmouth.—Sand and gravel production increased 16 percent in total tonnage and 23 percent in total value. Bennett Sand & Gravel Co., Inc., at Manasquan produced sand for building purposes and

gravel for building and paving uses. Hause Gravel Co. at Asbury Park and New Jersey & Sand Co. at Farmingdale produced sand and gravel for building purposes. Joseph Scarano produced sand and gravel for paving purposes at Wayside. Frank Z. Sindlinger, Inc., at Wall Township produced gravel for paving purposes. Walling & Son at Hazlet produced bank-run gravel for fill. Fary's Gravel Pit, Inc., at New Shrewsbury produced gravel for paving and fill.

Morris.—Alan Wood Steel Co. continued to produce magnetic ore from its Scrub Oaks mine near Dover. The ore was beneficiated magnetically to an iron concentrate and shipped to the company's blast furnace at Conshohocken, Pa. Crushed stone, sand, and grit were sold as byproducts from this mine. Shahmoon Industries, Inc., continued to report its Mount Hope iron mine as idle, but shipped iron ore concentrate from stockpiles that had been mined and beneficiated in previous years. Sand and gravel production increased 27 percent in total tonnage and 28 percent in total value. The county led 13 other sand-and-gravel-producing counties in total tonnage produced, with 3.2 million tons. Houdaille Construction Materials, Inc., with plants at Kenvil and Riverdale, was the largest producer of sand and gravel for building and paving purposes. Pequannock Sand & Gravel Division of Union Building & Construction Corp. produced sand for building, paving, and fill uses and gravel for building and paving purposes at Pequannock. T. Landi & Sons, Inc., at Morristown produced sand and gravel for building purposes. Berkshire Sand & Stone Co. at Oak Ridge produced sand for building, fill, and ice control purposes and gravel for building, fill, and miscellaneous uses. Alan Wood Steel Co., at its Scrub Oaks mine near Dover, produced sand for building, paving, blocks, bituminous concrete, ready-mixed concrete, and ice control. Saxton Falls Sand & Gravel Co., Inc., near Stanhope produced sand and gravel for building and paving purposes. Samuel Braen's Sons produced sand for building and paving purposes at its Pequannock plant. Whippany Sand & Gravel Co. at Whippany produced sand for building purposes and gravel for paving purposes. Wharton Sand & Stone Co. at Montville produced sand and gravel for building, paving, fill, and ice control purposes. Certified Aggregates Co., Inc., near Netcong produced sand and gravel for building, fill, and ice control purposes. Conklin Brothers at Montville produced sand for fill purposes. Granite was quarried and crushed for riprap, concrete aggregate, and roadstone by Braen Industries, Inc., at Riverdale and for concrete aggregate, roadstone, and screenings by Shahmoon Industries, Inc., at Mount Hope. Mineral specimens of carnelian were collected at Sterling by Charles H. Weber, Jr., and Marcelle Weber.

Ocean.—Sand and gravel production increased 12 percent in total tonnage and 15 percent in total value. Houdaille Construction Materials, Inc., at Lakewood produced sand and gravel for building and paving purposes. Atlantic Gravel Co. at Toms River produced sand and gravel for building purposes. Lacey Materials, Inc., at Forked River, Brick-Wall Corp. at New Shrewsbury, and Clayton's Sand & Gravel, Inc., at Barnegat produced sand and gravel for building and paving purposes. Robert E. Kalsch produced gravel from his Staffordville pit for fill and grading lots. Ralph Clayton & Sons at Lakewood produced sand for mason work and gravel for paving

and fill purposes. New Jersey Pulverizing Co., at its Pinewald plant near Bayville, produced industrial unground sand for molding, blast, engine, filtration, and other uses; and industrial ground sand for abrasives, filler, and foundry uses. Brown & Burdge at Point Pleasant Ocean produced sand for building and paving purposes.

The Glidden Co. produced ilmenite concentrates from a titanium bearing sand deposit near Lakehurst.

Passaic.—Stone production increased 8 percent in total tonnage and 11 percent in total value. The largest stone producer was Samuel Braen's Sons with operations at Haledon and North Haledon quarrying crushed basalt (traprock) for concrete aggregate, roadstone, and riprap. Houdaille Construction Materials, Inc., at Montclair, Sowerbutt Quarries, Inc., at Prospect Park, Great Notch Corp. at Little Falls, and Union Building & Construction Corp. at Clifton also quarried and crushed basalt (traprock) for concrete aggregate and roadstone. Roofing granules were produced from basalt (traprock) for roofing shingles and siding by Great Notch Granules Co. at Little Falls and H. B. Reed Corp. at Passaic. Gneiss stone was quarried and crushed by Passaic Crushed Stone Co., Inc., at Pompton Lakes for concrete aggregate and roadstone.

Sand and gravel production increased 37 percent in total tonnage and 20 percent in total value. Van Decker Brothers, Inc., at Wayne was the largest sand and gravel producer for building purposes. Van Orden Sand & Gravel Co., Inc., at Wayne produced sand and gravel for building purposes and sand for fill. Herbert J. Hinchman & Son, Inc., produced sand and gravel for ready-mixed concrete near Wayne. Elbert Van Orden produced sand for building purposes near Ringwood.

Mineral specimens of zeolites were collected at Paterson by Wesley A. Crozier.

Somerset.—Basalt (traprock) production continued to make Somerset County the leading stone-producing county in the State with 5.5 million tons valued at $11.4 million, a slight increase over that of 1962. The largest stone producer was Houdaille Construction Materials, Inc., with operations at Millington and Bound Brook quarrying crushed basalt (traprock) for jetty riprap, concrete aggregate, and roadstone. Kingston Trap Rock Co. quarried diabase traprock at Kingston for riprap, concrete aggregate, roadstone, and railroad ballast. Basalt (traprock) was also quarried by Somerset Crushed Stone Division of Anthony Ferrante & Sons, Inc., at Bernardsville, Fanwood Stone Crushing & Quarry Co. at Watchung, and Dock Watch Quarry Pit, Inc., at Martinsville for concrete aggregate and roadstone. Minnesota Mining & Manufacturing Co. quarried basalt (traprock) for concrete aggregate, roadstone, and roofing granules at Belle Mead. Artificially colored roofing granules were produced by The Ruberoid Co. at South Bound Brook and Minnesota Mining & Manufacturing Co. at Belle Mead.

Clay production decreased 1 percent in total tonnage and value. Natco Corp. produced miscellaneous clay and shale from its New Brunswick pit near Middlebush for manufacturing building brick and other heavy clay products. New Jersey Shale Brick & Tile Manufacturing Co. at Somerville produced miscellaneous clay and

shale for manufacturing building brick. American Vitrified Products Co. at Somerville produced miscellaneous clay and shale for manufacturing vitrified sewer pipe.

Sussex.—The Sterling Hill mine at Ogdensburg produced the entire year and shipped crushed crude zinc ore to Palmerton, Pa., for smelting. The smelter also reported production of manganiferous zinc residuum from this ore.

Limestone was quarried and crushed by Limestone Products Corp. of America at Newton for flooring filler, agricultural purposes, mineral food, concrete aggregate, roadstone, asphalt filler, poultry grit, lime manufacture, rubber filler, flux, filter beds, and other uses. Farber White Limestone Co. at Franklin quarried and crushed limestone for agricultural purposes, concrete aggregate, roadstone, asphalt filler, roofing spar, white aggregate, fertilizer filler, and plaster whiting.

Sand and gravel production decreased 21 percent in total tonnage but increased 72 percent in total value. Sparta Sand & Gravel Co., Inc., at Sparta produced sand and gravel for building and paving purposes. Limestone Products Corp. of America at Lime Crest and Andover Industries at Andover produced sand and gravel for construction purposes. F. W. Bennett & Son at Lafayette produced sand and gravel for construction purposes.

Hydrated lime was produced by Limestone Products Corp. of America at its Lime Crest plant at Newton and shipped to points within New Jersey and six other States for water purification and softening, finishing lime, mason's lime, and agricultural lime. Mineral specimens of calcite were collected at Franklin by Missouri Minerals, Inc.

Union.—Basalt (traprock) was quarried by Houdaille Construction Materials, Inc., at Summit and crushed for concrete aggregate and roadstone. Mineral specimens of zeolites and associated minerals were collected at Summit by Charles H. Weber, Jr., and Marcelle Weber. Sulfur was recovered as a byproduct in the liquid purification of gas by the general chemical process by Allied Chemical Corp. at its Bayway plant in Elizabeth. Certified Industrial Products, Inc., at Hillside expanded crude perlite for use in building plaster, concrete, and soil conditioning.

Warren.—Alan Wood Steel Co. produced magnetite ore from its Washington mine near Oxford. The ore was beneficiated magnetically to an iron concentrate and shipped to the company's blast furnace at Conshohocken, Pa. Sand and gravel production increased 26 percent in total tonnage and 56 percent in total value. Steckel Concrete Co. at Phillipsburg was the largest producer of sand and gravel for ready-mixed concrete and construction purposes. Houdaille Construction Materials, Inc., produced sand and gravel at Carpenterville for building and paving purposes. Van Horn Sand & Gravel Co. at Belvidere produced sand and gravel for building and paving purposes and gravel for fill. Harry W. Folkner at Buttzville produced sand for construction purposes. Marble was quarried by The Royal Green Marble Co., Inc., near Phillipsburg for green and royal green marble chips used in terrazzo flooring.

The Mineral Industry of New Mexico

By W. E. Burleson [1]

MINERAL output in New Mexico reached a near alltime high of $686.8 million representing a 2-percent increase over the $675.8 million reported in 1962.

Mineral fuels provided $459.7 million, 67 percent of the State total value of minerals produced; nonmetals $129.4 million, 19 percent; and metals $97.7 million, 14 percent. By comparison with production in 1962, mineral fuels gained 3 percent (from $448.2 to $459.7 million) and nonmetals 22 percent (from $105.8 to $129.4 million); metals declined 20 percent (from $121.8 to $97.7 million).

Most important gains in the minerals fuels group were in coal, 117 percent, and helium, 191 percent.

Nonmetals declined in production value of clays, lime, and mica, but increased strongly in cement, gypsum, potassium salts, pumice, sand and gravel, and stone. Most important increases occurred in potassium salts, 18 percent; sand and gravel, 60 percent; cement, 28 percent; and stone, 52 percent.

Significant in the metals group were the decreases in output values of uranium and zinc. Uranium decreased 35 percent, and zinc decreased 41 percent. The uranium decrease resulted mainly from the U.S. Atomic Energy Commission (AEC) stretchout program.

The State was the Nation's leading producer of perlite, potassium salts, and uranium ore. All counties except Torrance reported mineral production.

Multimillion-dollar developments in progress or recently completed were the expansions at all seven potash operations; coal production from an open-pit coal mine; the transfer of two major uranium processing mills; conversion from track to truck haulage and plant expansions at an open-pit copper mine; improvements and new-plant construction for petroleum and natural gas liquids; plant expansion at a gypsum operation; and initial-stage planning for a new mill and open-pit mine at a molybdenum deposit near Questa. One manganese mine and several copper and lead-zinc mines were reactivated.

Employment and Injuries.—Preliminary data compiled by the Federal Bureau of Mines for the employment and injuries in the mineral industries in the State, excluding the petroleum industry, are shown in table 3.

Legislation and Government Programs.—An Office of Minerals Exploration (OME) contract with Henry Clay Mines, Inc., was in effect; however, little was accomplished underground.

[1] Mining engineer, Bureau of Mines, Socorro, N. Mex.

TABLE 1.—Mineral production in New Mexico [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	252	$4	600	$6
Beryllium concentrate—short tons, gross weight	34	19		
Carbon dioxide (natural)—thousand cubic feet	826,810	74	854,339	63
Clays—thousand short tons	52	156	[2]	140
Coal (bituminous)—do	677	2,595	1,945	5,629
Copper (recoverable content of ores, etc.)—short tons	82,683	50,933	83,037	51,151
Gem stones	[3]	45	[3]	45
Gold (recoverable content of ores, etc.)—troy ounces	7,529	264	7,805	273
Gypsum—thousand short tons	151	564	179	656
Helium—thousand cubic feet	27,377	958	79,624	2,787
Iron ore (usable)—thousand long tons, gross weight	9	121	[2]	[2]
Lead (recoverable content of ores, etc.)—short tons	1,134	209	1,014	219
Lime—thousand short tons	29	403	27	377
Manganese concentrate (35 percent or more Mn) short tons, gross weight	[2]	[2]	5,362	137
Manganiferous ore (5 to 35 percent Mn) short tons, gross weight	[2]	[2]	41,144	[2]
Mica (scrap)—short tons	5,731	140	[2]	[2]
Natural gas—million cubic feet	804,612	92,530	808,377	96,197
Natural gas liquids:				
LP gases—thousand gallons	661,330	20,359	728,200	21,801
Natural gasoline and cycle products—do	273,969	16,775	291,388	17,555
Perlite—short tons	258,164	2,143	259,113	2,212
Petroleum (crude)—thousand 42-gallon barrels	109,328	314,883	[4] 109,613	[4] 315,632
Potassium salts—thousand short tons, K_2O equivalent	2,208	85,124	2,644	100,570
Pumice—thousand short tons	308	741	322	850
Salt—do	43	334	57	518
Sand and gravel—do	6,889	8,021	8,402	12,843
Silver (recoverable content of ores, etc.)—thousand troy ounces	302	327	256	328
Stone—thousand short tons	2,004	2,782	2,509	4,236
Uranium ore—short tons	3,478,238	63,504	2,304,577	41,372
Vanadium—do	[2]	[2]	23	[2]
Zinc (recoverable content of ores, etc.)—do	22,015	5,063	12,938	2,976
Value of items that cannot be disclosed: Cement, sheet mica (1962), molybdenum, and values indicated by footnote 2		6,743		8,249
Total		[5] 675,814		686,822

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Weight not recorded.
[4] Preliminary figure.
[5] Revised figure.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$340,129	1958	$563,052
1953	377,255	1959	599,371
1954	404,011	1960	649,999
1955	457,258	1961	682,783
1956	521,279	1962	658,062
1957	543,507	1963	667,734

The AEC concluded stretchout agreements for purchasing uranium concentrate. The concentrate purchase agreement with The Anaconda Company, signed December 27, 1963, and the first to be negotiated, deferred production and delivery of 3 million pounds of uranium to 1967 and 1968. The AEC then will purchase an additional quantity of concentrates in 1969 and 1970 equal to the quantity delivered in 1967 and 1968, but not in excess of the 3 million pounds deferred.

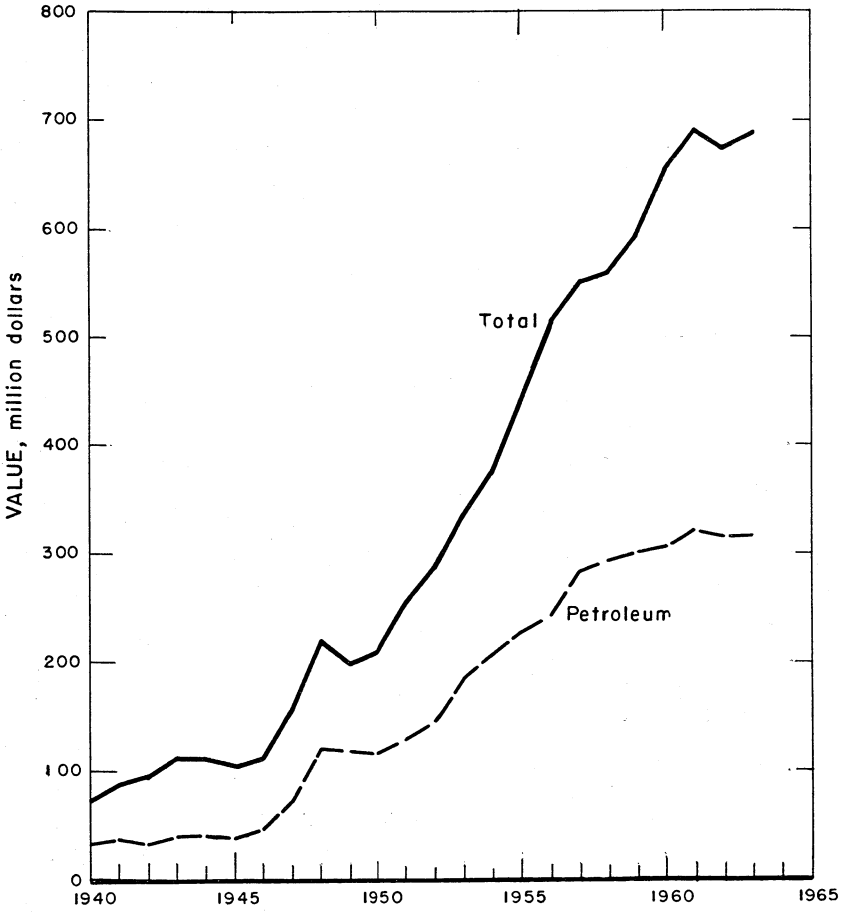


FIGURE 1.—Value of petroleum, and total value of mineral production in New Mexico, 1940–63.

In November, the Area Redevelopment Administration arranged a $313,000 industrial loan with Reese Mining and Manufacturing Co. of Silver City to establish a clay-mining and brick-manufacturing operation; the loan was granted.

Contracts totaling $34.7 million were awarded to contractors on work for the Federal Bureau of Public Roads, New Mexico State Highway Department, and county highway departments. The contracts consisted of $18.4 million for interstate road construction, $12.4 million for the Federal-Aid Primary and Secondary (ABC) Highway System, and $3.9 million for 100-percent State-financed roads. Planned for 1964 were $30.3 million in interstate contracts, $20.2 million in ABC construction, and $203,000 for 100-percent State-financed highways. These figures represented an increase of 46 percent over the total amount awarded in 1963.[2]

[2] Engineering News-Record. State Highway Contracts Will Rise. Mar. 26, 1964, pp. 13–15.

TABLE 3.—Employment and injuries in the mineral industries[1]

Industry	Number of operations	Average number of men employed	Total man-hours worked	Injuries		Frequency rate (injuries per million man-hours)
				Fatal	Nonfatal	
1962:						
Nonferrous mines, mills, and smelters	92	1,743	4,117,758	1	194	47.4
Metal mines and mills (other)	10	90	164,087	1	13	85.3
Uranium mines and mills	63	2,873	6,799,312	7	159	24.4
Potash mines and mills	13	2,148	5,216,520	3	181	35.3
Nonmetal mines and mills (other)	71	265	399,534		15	37.5
Stone quarries and plants	57	259	470,639		7	14.9
Sand and gravel plants	117	496	820,241		20	24.4
Coal mines	22	304	341,446	2	10	35.1
Total	445	8,178	18,329,537	14	599	33.4
1963:[2]						
Nonferrous mines, mills, and smelters	96	1,689	3,226,411	1	170	53.0
Metal mines and mills (other)	6	123	208,790		25	119.7
Uranium mines and mills	49	2,286	4,539,551	1	148	32.8
Potash mines and mills	16	2,562	7,082,796	1	175	24.8
Nonmetal mines and mills (other)	60	241	382,873		2	5.2
Stone quarries and plants	71	283	562,432		5	8.9
Sand and gravel plants	127	632	1,034,276		16	15.5
Coal mines	17	294	461,569		11	23.8
Total	442	8,110	17,498,698	3	552	31.7

[1] Excludes employees in all mineral fuels industries except the coal industry as well as officeworkers.
[2] Preliminary figures.

On July 1, the Federal Office of Saline Water dedicated its 1-million-gallon-per-day brackish-water plant at Roswell. The plant, costing $1.7 million, was the largest conversion installation in the Nation.

The Agency for International Development awarded two contracts totaling $500,000 to potash firms at Carlsbad for potassium salts to be shipped to South Korea.

Three mines were certified to participate in the Federal Lead-Zinc Stabilization Program; one of these, a lead mine, received payments totaling $880.

Water.—The Bureau of Mines conducted a canvass of the consumption of water in the mineral industries in 1962. Table 4 shows the data collected for the entire industry; table 5 shows, in more detail, the use of water in oil- and natural-gas-well drilling. Based on responses, the data also include estimates where necessary.

TABLE 4.—Water used during 1962 in the mineral industry, by type of operations

(Million gallons)

Type of operation [1]	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	(2)		(2)	(2)		0.02
Coal mines	41	300	341	37	4	32.23
Metal mines and mills	4,390	2,737	7,127	932	3,458	36.11
Nonmetal mines and mills	5,262	33,757	39,019	2,830	2,432	59.23
Sand and gravel operations	313	157	470	276	37	39.57
Natural gas processing plants	3,076	133,506	136,582	1,230	1,846	82.84
Total	13,082	170,457	183,539	5,305	7,777	
Oil- and natural gas-well drilling			480			
Secondary-recovery operations			2,257			
Total			2,737			
Grand total			186,276			

[1] Water survey did not include cement plants, lime plants, metal smelters, metal refineries, petroleum refineries, natural-brine operations, sand and gravel operations using suction dredges without preparation plants, stockpile operations, and assessment work operations.
[2] Less than 1 million gallons.

TABLE 5.—Water used during 1962 for wells drilled, by counties

County	Number of wells	Total footage drilled (feet)	Fresh water used	Saline water used	Other water used	Total water used	Total barrels per foot
			42-gallon barrels				
Chaves	41	131,525	193,342			193,342	1.47
Colfax	3	10,631	14,883			14,883	1.40
Curry	1	7,537	8,592			8,592	1.14
Dona Ana	1	7,346	10,284			10,284	1.40
Eddy	339	1,108,136	1,041,648	6,226		1,047,874	.95
Lea	563	3,809,652	6,390,449	292,405	98,327	6,781,181	1.78
Lincoln	1	3,429	4,801			4,801	1.40
Luna	1	13,244	18,542			18,542	1.40
McKinley	30	18,892	26,449			26,449	1.40
Mora	1	1,048	1,467			1,467	1.40
Otero	3	6,656	9,318			9,318	1.40
Rio Arriba	232	1,184,470	1,172,625		34,888	1,207,513	1.02
Roosevelt	63	444,472	301,399	31,955		333,354	.75
Sandoval	23	49,229	57,598			57,598	1.17
San Juan	363	1,799,972	1,511,976		207,585	1,719,561	.96
Torrance	1	4,117	5,764			5,764	1.40
Union	1	1,000	1,400			1,400	1.40
Total	1,667	8,601,356	10,770,537	330,586	340,800	11,441,923	[1] 1.33

[1] Average.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral fuels (carbon dioxide, coal, helium, natural gas, natural gas liquids, and petroleum) represented 67 percent of the value of mineral production in the State. Value for fuels was 3 percent greater than in 1962.

Carbon Black.[3]—Continental Carbon Co. and United Carbon Co. produced carbon black from natural gas at two plants in Lea County.

[3] New Mexico Oil & Gas Engineering Committee. Annual Report. V. 1, 1963, p. 359.

The Columbian Carbon Co. continued shipments from stock through September from its plant, which had been shut down in October 1962. The quantity of natural gas used in the production of carbon black was 16.3 billion cubic feet, a decline of 43 percent compared with that of 1962.

Carbon Dioxide.—Carbon dioxide gas production from wells in Harding County increased 3 percent. Schwartz Carbonic Co., one of the three operators producing carbon dioxide gas, worked at only 41 percent of plant capacity. The gas was compressed and sold to consumers as dry ice and liquid carbon dioxide, mainly for refrigerating fruit and vegetable trucks. At Sandia and Holloman Air Force Bases the gas was used as a coolant for liquid oxygen and in equipment for missile research.

Coal (Bituminous).—Coal production had an increase of 187 percent in quantity and 117 percent in value compared with that of 1962. A significant contribution to the expanded output resulted from production at the Navajo strip mine, about 23 miles southwest of Farmington, and operated through lease agreement on the Navajo Reservation by Utah Construction & Mining Co. The mine supplied coal to generate 350,000 kilowatts of thermoelectric power at the Arizona Public Service Co. recently erected Four Corners powerplant. The project represented a total investment of $95 million by Arizona Public Service Co. and approximately $9 million for exploration, development, and construction by Utah Construction & Mining Co. The powerplant was placed on stream in May 1963. During May, construction was started on a third unit (225,000 kilowatt) at a cost of $25 million; completion was scheduled for summer 1964. The mine and plant were dedicated jointly June 21, 1963.

Coal was exploited from three strip and seven underground mines; of the total, three underground mines were in Colfax County, two strip and one underground in McKinley, one of each type in San Juan, and one underground in both Rio Arriba and Sandoval. The principal producers were the Koehler (underground) mine, Kaiser Steel Corp., in Colfax County; McKinley (strip) mine, The Pittsburg & Midway Coal Mining Co., in McKinley; and the Navajo (strip) mine, Utah Construction & Mining Co., in San Juan. The Koehler and McKinley mines each increased production.

The Pittsburg & Midway Coal Mining Co. shipped coal to the Arizona Public Service Co. steam plant near Joseph City, Ariz.; Kaiser Steel Corp. produced coal mainly for the company foundries at Fontana, Calif.

Helium.—The Federal Bureau of Mines Navajo (helium) plant at Shiprock recovered helium; output and value each increased 191 percent. Gas containing helium was obtained additionally through a gas-purchase agreement with Continental Oil Co. from wells in the Table Mesa area. Federal agencies used about 78 percent of the helium shipped by the Bureau.

Natural Gas.—Natural gas production from oil wells and processed oil well gas increased 3 percent in quantity and 5 percent in value in 1963. The State was rated fifth in the Nation in net production of natural gas and proved reserves.[4]

[4] Oil and Gas Journal. V. 62, No. 13, Mar. 30, 1964, p. 35.

Information compiled by the New Mexico Oil Conservation Commission and published by the New Mexico Oil & Gas Engineering Committee [5] showed that a total of 16,794 oil wells and 7,334 gas wells produced 793.2 billion cubic feet of gas; 56 percent of the production was from wells in the southeastern part of the State. The northwestern fields comprised 37 of the total 79 oil and gas pools; they flowed 92 percent, or 321.6 billion cubic feet, from 4,518 natural gas wells. The southeastern fields produced 444.5 billion cubic feet of gas from 17,732 oil-gas and gas wells, of which 61 percent, 272.6 billion cubic feet, was produced from oil-gas wells at 498 of the total 588 pools; the balance was from gas-well production.

There were 729 oil and 334 gas wells completed. Ninety percent of the total gas output was processed at natural gas plants for recovery of natural gas liquids.

TABLE 6.—Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

Commodity	Proved reserves Jan. 1, 1963	Extensions and revisions	New discoveries	Proved reserves Jan. 1, 1964	Changes from 1963
Petroleum (crude)—thousand barrels	1,064,590	32,487	18,111	1,010,729	−53,861
Natural gas liquids—do	517,209	71,449	1,404	558,233	+41,024
Natural gas—million cubic feet	14,112,734	1,562,784	91,322	15,037,822	+925,088

Source: Oil and Gas Journal. V. 62, No. 13, Mar. 30, 1964, pp. 35–36.

Natural Gas Liquids.—The State was rated third in the Nation in production of natural gas liquids and proved reserves.[6] Natural gasoline, butane, and propane were extracted from oil-well gas at 26 plants in the southeastern counties and at 5 in the northwestern counties; total all-service plants increased from 37 to 38. Recovery of natural gasoline increased 6 percent in quantity and 5 percent in value; recovery of liquid-petroleum gases (butane and propane) increased 10 percent in quantity and 7 percent in value over that of 1962. The annual report of the New Mexico Oil & Gas Engineering Committee showed 720.8 billion cubic feet of gas processed. Of the residual gas, 41.1 billion cubic feet was used for plant fuel and 6.2 billion for lease fuel; 614.3 billion was sold to pipeline companies; 3.5 billion was used for repressuring; and 5.8 billion was vented. The recovery of natural gasoline was 11.3 million barrels, for butane 8.3 million, and for propane 6.7 million.

Continental Oil Co. and Marathon Oil Co. each completed $1 million gasoline plants in the southeastern part of the State. The Southern Union Gas Co. completed an addition to its Kutz Canyon facility at Farmington.

Petroleum.—For the 5th consecutive year and, except for 1961, petroleum production again exceeded 100 million barrels; the output was greater than that for any other year. The State continued to retain its sixth position in the Nation's output of oil.

[5] New Mexico Oil & Gas Engineering Committee. Annual Report. V. 1–2, 1963, p. 2.
[6] Oil and Gas Journal. V. 62, No. 13; Mar. 30, 1964, p. 36.

Output was from 16,794 oil wells; 14,916 in the southeastern counties (Chaves, Eddy, Lea, and Roosevelt) and 1,878 in the northwestern counties (McKinley, Rio Arriba, Sandoval, and San Juan). Major production was from the southeastern Permian basin fields, providing 93 percent of the total. Included were 3.2 million barrels of distillate obtained from an additional 7,334 wells; the 4,518 in the northwestern counties produced 58 percent of the distillate. Total production was from 667 pools, classified as 540 oil and 127 gas; 79 pools, 42 oil and 37 gas, were in the northwestern counties.[7] Average production allowables were about the same as those of 1962.

TABLE 7.—Crude petroleum production, by counties[1]

(Thousand 42-gallon barrels)

County	1962	1963[2]	Principal fields (those producing more than 1 million barrels) in 1963 in order of production
Chaves	4,559	5,214	Caprock.
Eddy	15,103	15,550	Empire Abo, Loco Hills, Grayburg Jackson.
Lea	74,261	76,067	Vacuum, Denton, Hobbs, Maljamar, Langlie, Drinkard, Eunice, Crossroads, Jalmat, Eumont, Lovington, Corbin Abo, Lusk, Blinebry, Justice, Saunders, Caprock East.
McKinley	156	144	
Rio Arriba	1,182	1,527	
Roosevelt	4,624	2,996	Allison.
Sandoval	15	11	
San Juan	9,428	8,104	Bisti, Horseshoe.
Total	109,328	109,613	

[1] Based on New Mexico Oil & Gas Engineering Committee, Annual Report 1963. V. 1-2, 1963, 502 pp., adjusted to Bureau of Mines total.
[2] Preliminary figures.

The New Mexico Oil Conservation Commission report showed that exploratory and development drilling were not as great as in 1962, 1,489 completions compared with 1,741 in 1962; of these, 334 were completed as gas wells, 729 oil, and 426 dry holes. Wildcat wells increased from 295 in 1962 to 318 in 1963; of these, 40 were completed as oil wells, 27 gas, and 251 dry holes. Total footage drilled, 6.8 million feet, decreased 21 percent (1.8 million feet) in comparison with that of 1962. Average depth per well was 5,300 feet. Field wells drilled accounted for 964 wells. Multiple-completion wells totaled 106.

Lea and Roosevelt Counties were the most active Permian basin areas; scattered wildcat wells extended the basin boundaries westward. Active areas included, mainly, the Allison in Lea and Roosevelt Counties; the Dakota, Cha Cha-Totah, and Horseshoe Canyon in San Juan; the Langlie Mattix in Lea; and the new Indian basin (gas) in Eddy.

The deepest well in the State, the Shell Oil Co. 1-BE Shell-Federal well in southwestern Lea County, was extended to 17,895 feet during the year. The Pure Oil Co. Salado Draw Delaware field well was being drilled to 22,000 feet.

Southwest Production Co., Dallas, Tex., purchased the working interest in the San Juan basin properties of the International Oil and Gas Co., Denver, Colo. Atlantic Refining Co. acquired the interests of Hondo Oil and Gas Co. of Roswell.

[7] New Mexico Oil & Gas Engineering Committee. Annual Report 1963. V. 1, pp. 2-14; v. 2, pp: 2-3.

TABLE 8.—Wildcat- and development-well completions in 1963, by districts and counties

District and county	Oil	Gas	Dry	Total	Footage
East New Mexico:					
Wildcat:					
Chaves	6	3	27	36	144,500
De Baca			2	2	5,100
Dona Ana			3	3	19,100
Eddy	10	13	54	77	377,200
Lea	17	9	77	103	843,500
Otero			1	1	4,000
Roosevelt	3	2	10	15	106,100
Total	36	27	174	237	1,499,500
Development:					
Chaves	16		3	[1] 23	63,900
Eddy	93	9	36	[2] 143	471,500
Lea	292	6	52	[3] 358	2,478,800
Roosevelt	43		2	45	222,900
Total	444	15	93	[4] 569	3,237,100
West New Mexico:					
Wildcat:					
Guadalupe			1	1	3,900
Hidalgo			1	1	300
McKinley			20	20	20,600
Rio Arriba	1		8	9	42,100
Sandoval			11	11	34,600
San Juan	3		34	37	118,300
Santa Fe			1	1	2,800
Valencia			1	1	400
Total	4		77	81	223,000
Development:					
McKinley	2		1	[5] 6	3,300
Rio Arriba	28	140	6	174	910,600
Sandoval		3	11	14	16,000
San Juan	78	96	24	[5] 201	905,300
Total	108	239	42	[6] 395	1,835,200
Total all drilling	592	281	386	[7] 1,282	6,794,800

[1] Includes 4 service wells.
[2] Includes 5 service wells.
[3] Includes 8 service wells.
[4] Includes 17 service wells.
[5] Includes 3 service wells.
[6] Includes 6 service wells.
[7] Includes 23 service wells.

Source: The Oil and Gas Journal.

NONMETALS

Nonmetallic mineral production contributed 19 percent of the total value of the State mineral output, representing an increase of 22 percent over that of 1962. The principal output values, in declining rank, were potassium salts, sand and gravel, cement, stone, and perlite.

Barite.—Production of barite, reported only from Socorro County, increased from 252 tons in 1962 to 600 tons. The crushed barite was used mainly as a constituent in oil-well-drilling mud.

Cement.—Continuous operation of the Tijeras plant, Ideal Cement Co., Bernalillo County, was the principal reason for an increase of 36 percent output in shipments of portland and masonry cements over that of 1962. Sales were within the State and to Arizona, Colorado, Oklahoma, Southern California, Texas, and Utah.

Clays.—Production value of fire clay from Hidalgo and Luna Counties and miscellaneous clay from Bernalillo, Dona Ana, and McKinley Counties, cumulatively, was 10 percent less than in 1962. Separately, miscellaneous clay production increased and that of fire clay declined. Reduced output in Hidalgo County was more than offset by increased production in Bernalillo County. Two clay operations, one each in Luna and McKinley Counties, ceased activities. Principal uses were for cement and other building materials.

Gem Stones.—Luna County was ranked first in sales of gem stones—about one-third of the total output—and was followed in order of value by Eddy, Valencia, Hidalgo, and Catron Counties. Agate accounted for the bulk of the total reported; other gem materials collected were amethyst, chalcedony, jasper, onyx, petrified wood, quartz crystals, smithsonite, and turquoise.

Gypsum.—Production of gypsum increased 19 percent in quantity and 16 percent in value compared with that of 1962. Important users of gypsum were American Gypsum Co., Albuquerque plant; Kaiser Gypsum Co., Inc., Rosario plant; and Ideal Cement Co., Tijeras plant. White Mesa Gypsum Co. supplied gypsum for American Gypsum Co.; Kaiser Gypsum Co. mined its deposit; and Duke City Gravel Products Co. of Albuquerque mined gypsum for Ideal Cement Co. A $1 million plant expansion started early in 1963 by American Gypsum Co. was to increase wallboard production about 50 percent.

Lime.—The Chino Mines Division of Kennecott Copper Corp. operated a rotary kiln and other facilities which yielded 27,125 tons of hydrated lime used in processing copper ores.

Mica.—Output of scrap mica increased, but value decreased compared with that of 1962. Production of mica from two deposits in Rio Arriba County and one in Taos was exploited from openpit mines. Important buyers of scrap mica were Los Compadres Mica Co., Ojo Caliente, and Mineral Industrial Commodities of America, Inc. (M.I.C.A., Inc.), Pojoaque. Mica-grinding and processing mills were operated by the two companies.

The Joseph (mica) mine and mill, near Ojo Caliente, was purchased April 1 by M.I.C.A., Inc., Santa Fe, from Alaska International Corp., Albuquerque.

Perlite.—The State accounted for 80 percent of the total production of perlite in the Nation; for the last 7 years it has been the source of over 50 percent of the Nation's total tonnage. The four principal operators were Great Lakes Carbon Corp., Johns-Manville Products Corp., United Perlite Corp., and United States Gypsum Co. The No Aqua area, in the north-central section of the State, continued to lead in total output of perlite from three open-pit operations. All of the sized crude perlite from around No Aqua was transported by truck to the railroad-loading facilities at nearby Antonito, Colo. United States Gypsum Co. mined and milled perlite at its Grants operations. The four principal perlite producers shipped sized products to company-owned and other expanding plants outside the State. Great Lakes Carbon Corp. expanded about 20 percent of its perlite at the company-owned Antonito plant before shipment by railroad. Perlite was used mainly in building construction, filter aids, and cementing material for oil-well drilling.

TABLE 9.—Crude perlite sold or used by producers

Year	Short tons	Value (thousands)
1959	240,642	$2,121
1960	240,593	2,119
1961	245,654	2,159
1962	258,164	2,143
1963	259,113	2,212

Potash.—The State provided 92 percent of the Nation's total output of potassium salts. The average value of the 4.2 million tons of salts sold dropped from $22.79 per ton to $22.36. Stocked products increased from approximately 250,000 to 400,000 tons. Production of crude potash ores (sylvite and langbeinite) rose to an alltime high. The grade (K_2O equivalent) of the crude ores averaged 18.8 percent compared with 18.5 percent in 1962. Increase in production of marketable potassium salts resulted from continuous operations and improved plant facilities.

Important expansions and developments took place at all seven of the potash mines which were in Eddy and Lea counties.

TABLE 10.—Potassium salts production and sales

(Thousand short tons)

Year	Crude salts,[1] mine production		Marketable potassium salts					
			Production			Sales		
	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Value [2] (thousands)	Gross weight	K_2O equivalent	Value (thousands)
1959	13,933	2,588	3,707	2,189	$74,117	3,821	2,258	$76,725
1960	15,071	2,841	4,138	2,440	82,645	4,092	2,412	81,653
1961	15,653	2,934	4,281	2,523	96,380	3,882	2,281	87,415
1962	14,115	2,619	3,758	2,208	85,124	4,206	2,476	95,851
1963	16,414	3,083	4,500	2,644	100,570	4,214	2,488	94,249

[1] Sylvite and langbeinite.
[2] Derived from reported value of "Sold or used."

Pumice.—Sales of crude and processed pumice, including pumicite, scoria, and volcanic cinders, increased 5 percent in quantity and 15 percent in value compared with that of 1962. A 36-percent rise in the use of pumice, scoria, and volcanic cinders as a lightweight concrete aggregate was the principal cause for the increase. Scoria constituted 36 percent of the total tonnage and 26 percent of the value of the output. Pumice was used at company-owned plants in manufacturing concrete blocks and roofing products. Crude and prepared pumice were sold for use as an abrasive, athletic track material, ballast, concrete admixture, concrete aggregate, filtering agent, insulating material, and soil conditioner; for manufacturing matches and paint; and for decorative stonework.

Two companies, one in Bernalillo County and the other in Valencia, ceased operations.

Salt.—Continued growth of the salt industry was evidenced by a 33-percent increase in output. The center of activity continued to be the Carlsbad area of Eddy County. The principal output was recovered from tailing from potash-refinery operations. Salt was produced from the Quemado solar-evaporation salt facility of Rocky Mountain Salt Co. in Catron County. Carlsbad Salt Products, Inc., New Mexico Salt Co., and The Salt Supply Co., Inc., were the major handlers of crude salt; and The Great Salt Lick, Inc., and Rocky Mountain Salt Co. were leaders in finished products. Markets included mostly stock ranchers, feed dealers, water-softener establishments, and State and county highway departments.

Sand and Gravel.—Total output of sand and gravel increased 22 percent in production and 60 percent in value. Average value of the total output was $1.53 per ton. Substantial increases occurred in sands used for building projects, although general uses of sands declined about 1 percent. Highway construction was the principal cause for gravel to rise from 5.4 million tons in 1962 to 7.1 million tons in 1963, at a value increase of $5.1 million. All counties excepting Torrance reported production. Bernalillo County led in output, supplying 16 percent of the total sand and gravel production. Of 125 active operations, 81 were commercial, producing about one half of the output, and 44 were Government-and-contractor. The principal operators for volume of material handled, in order of output, were Albuquerque Gravel Products Co., Armstrong & Armstrong, M. M. Sundt Construction Co.; J. W. Jones Construction Co.; Broce Construction Co. of New Mexico, Inc.; and Springer Transfer Co.

The U.S. Department of Commerce reported [8] that of 1,006.9 miles of road designated as a part of the Interstate Highway system in the the State, 385 miles was open to traffic, 278.9 miles was completed to full and acceptable standards, and 106.1 miles was improved sufficiently for present traffic. Work in progress on December 31 included

TABLE 11.—Sand and gravel production in 1963, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Bernalillo	1,347	$1,972	Mora	52	$70
Catron	78	72	Otero	329	489
Chaves	471	562	Quay	112	203
Colfax	93	129	Rio Arriba	366	453
Curry	15	15	Roosevelt	122	220
De Baca	105	165	Sandoval	518	887
Dona Ana	317	328	San Juan	275	359
Eddy	167	373	San Miguel	(1)	(1)
Grant	454	777	Santa Fe	450	942
Guadalupe	426	399	Sierra	184	405
Harding	75	106	Socorro	293	391
Hidalgo	80	80	Taos	12	12
Lea	44	91	Union	(1)	(1)
Lincoln	(1)	(1)	Valencia	341	537
Los Alamos	100	143	Undistributed	54	63
Luna	181	159			
McKinley	1,341	2,441	Total	8,402	12,843

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[8] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1962. Press release BPR 64–9, Feb. 7, 1964.

TABLE 12.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	770	$854	971	$1,272
Paving	383	461	179	233
Fill	59	59	43	23
Other	125	221	----	----
Industrial: Engine	1	3	2	7
Total	1,338	1,598	1,195	1,535
Gravel:				
Construction:				
Building	785	1,035	782	1,064
Paving	1,289	1,516	2,052	2,498
Railroad ballast	(1)	(1)	(2)	(2)
Fill	54	69	106	50
Other	23	37	----	----
Miscellaneous	101	129	38	47
Total	2,252	2,786	2,978	3,659
Total sand and gravel	3,590	4,384	4,173	5,194
Government-and-contractor operations:				
Sand:				
Building	22	67	3	4
Paving	130	221	100	58
Other	1	3	----	----
Total	153	291	103	62
Gravel:				
Building	10	30	102	101
Paving	3,129	3,303	4,024	7,486
Other	7	13	----	----
Total	3,146	3,346	4,126	7,587
Total sand and gravel	3,299	3,637	4,229	7,649
All operations:				
Sand	1,491	1,889	1,298	1,597
Gravel	5,398	6,132	7,104	11,246
Total	6,889	8,021	8,402	12,843

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Fill."

63.8 miles under construction and 199.3 miles in the engineering and right-of-way planning stage.

Stone.—Substantial increases occurred in the production of crushed limestone and miscellaneous stone; however, the use of crushed basalt dropped considerably. The tonnage and value of stone production increased 25 and 52 percent, respectively, compared with those of 1962. Output of stone was reported by 21 counties, a gain of 4 counties and 6 operations. The major producing counties were Bernalillo, Lea, and Quay. Bernalillo and Lea Counties doubled their value of output. Counties in which more than 100,000 tons was produced, in order of rank, were Bernalillo, Lea, Quay, Eddy, Curry, Chaves, Socorro, and Dona Ana. Crushed limestone and other miscellaneous stone were used principally at highway projects. The State highway commission reported production in excess of 700,000 tons of crushed stone used in road construction in the State.

TABLE 13.—Stone production in 1963, by counties

County	Short tons	Value	County	Short tons	Value
Colfax	6,630	$7,961	Rio Arriba	2,166	$41,573
Dona Ana	125,600	136,000	Roosevelt	28,847	42,548
Eddy	203,785	274,347	San Juan	200	200
Grant	66,405	67,297	San Miguel	264	3,700
Lea	427,071	893,463	Santa Fe	1,680	22,394
Lincoln	1,502	5,922	Socorro	128,196	324,651
Luna	190	2,200	Undistributed [1]	1,167,853	1,919,614
Otero	65,349	69,769			
Quay	283,000	424,500	Total	2,508,738	4,236,139

[1] Includes the following counties for which figures are withheld to avoid disclosing individual company confidential data: Bernalillo, Chaves, Curry, De Baca, McKinley, and Valencia.

TABLE 14.—Stone sold or used by producers, by kinds

Year	Basalt and related rocks (traprock)		Granite		Limestone		Marble	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1959	1,000	$5,200			224,501	$298,648	37	$732
1960	9,418	21,750	1,869	$2,492	696,268	927,717		
1961	2,025	2,025			1,164,575	1,516,250	80	11,029
1962	148,858	201,758			918,483	1,298,410	(1)	(1)
1963	6,716	8,211	996	25,997	1,264,243	2,017,667	(1)	(1)

Year	Sandstone		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1959	175,315	$179,996	60,362	$57,376	461,215	$541,952
1960	64	1,105	569,001	739,312	1,276,620	1,692,376
1961	115,331	87,587	571,098	588,775	1,853,109	2,205,666
1962	95	1,125	936,336	1,280,947	2,003,772	2,782,240
1963	(1)	(1)	1,236,783	2,184,264	2,508,738	4,236,139

[1] Figures withheld to avoid disclosing individual company confidential data; included with "Other stone."

Sulfur.—Output and value of elemental sulfur substantially increased during the year. Sulfur was recovered from sour gases by modified Claus processes at plants that included the Empire Abo plant of North Texas-New Mexico Division of Pan American Petroleum Corp., the Artesia plant of Phillips Petroleum Co., a plant of Sinclair Oil & Gas Co., and the Climax Chemical Co. plant near Oil Center. The Climax Chemical Co. plant was erected during the first half of 1962, and a charcoal unit was installed in 1963; all of the plant production of elemental sulfur was used by the company. The company chemical plant near Monument used hydrogen sulfide (H_2S) gas and elemental sulfur to produce sulfuric and muriatic acids.

Vermiculite.—Southwest Vermiculite Co. of Albuquerque operated its vermiculite-exfoliating plant throughout the year. Mill output was used principally as a lightweight aggregate. Crude vermiculite continued to be shipped from Libby, Mont., to the company Albuquerque plant.

METALS

The metals group, valued at $97.7 million, declined 20 percent in total value of output in comparison with that of 1962. Copper, the principal metal produced, increased in output from $50.9 to $51.1 million. Other principal metals, in order of value, were uranium $41.4, a decline of 35 percent, and zinc $3 million, a loss of 41 percent, compared with that of 1962.

Beryllium.—No shipments of beryllium-bearing ore were reported at the Harding mine, Taos County.

Copper.—Ranked fourth in the Nation in copper output for 1961 and 1962, the State was elevated to third in the Nation for 1963. Copper value exceeded that of uranium for the first time since 1957.

Copper output and value were approximately the same as those of 1962. The Chino open-pit mine, Kennecott Copper Corp., continued to be the leading producer. Three mines, Chino and Bayard (Continental), Grant County, and Bonney-Miser's Chest, Hidalgo County, accounted for about 98.7 percent of the State copper production. Copper was exploited from 36 operations, leach included, in 7 counties.

Approximately 60 percent of the State copper output was recovered from copper-bearing ore mined for its copper content; 39 percent was recovered by leaching mine-dump material. The remainder came from ore mined primarily for the contained lead and zinc or for the gold and silver content.

TABLE 15.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1954–58 (average)	48	2	7,379	3,064	$107	244	$221
1959	30	----	4,686	3,155	110	159	144
1960	33	----	7,804	5,423	190	304	275
1961	39	1	7,751	6,201	217	283	261
1962	22	----	7,687	7,529	264	302	327
1963	25	----	7,404	7,805	273	256	328
1848–1963	[3]	[3]	[3]	2,251,014	52,120	73,181	58,011

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	64,866	$43,660	3,327	$980	18,401	$4,555	$49,523
1959	39,688	24,369	829	191	4,636	1,066	25,880
1960	67,288	43,199	1,996	467	13,770	3,553	47,684
1961	79,606	47,764	2,332	480	22,900	5,267	53,989
1962	82,683	50,933	1,134	209	22,015	5,063	56,796
1963	83,037	51,151	1,014	219	12,938	2,976	54,947
1848–1963	2,505,560	1,055,292	337,430	47,243	1,267,187	240,563	1,453,229

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes re-treated, and ore, old tailings, old slag, or copper precipitates shipped to smelters during the calendar year indicated.
[2] Does not include gravel washed or tonnage of precipitates shipped.
[3] Data not available.

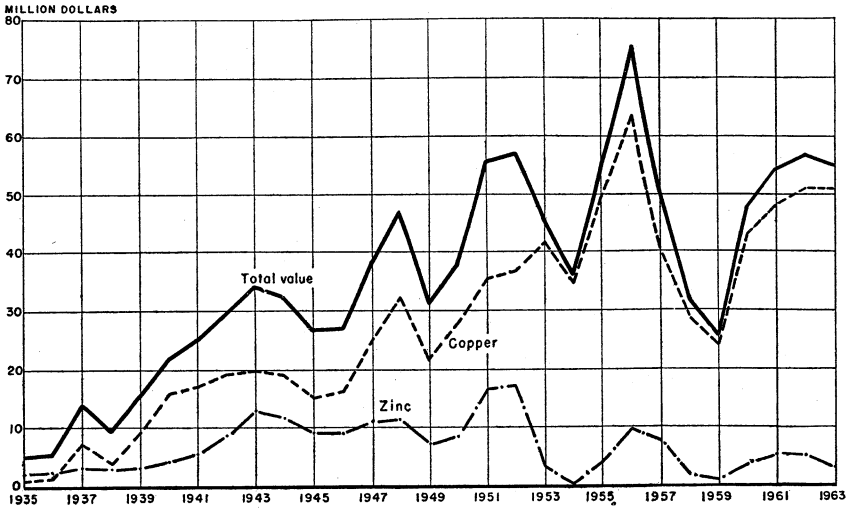


Figure 2.—Value of mine production of copper and zinc and total value of gold, silver, copper, lead, and zinc in New Mexico, 1935–63. The value of gold, silver, and lead produced annually has been relatively small.

TABLE 16.—Mine production of gold, silver, copper, lead, and zinc in 1963, by counties, in terms of recoverable metals

County	Mines producing (lode)	Lode material sold or treated [1] (short tons)	Gold		Silver	
			Troy ounces	Value	Troy ounces	Value
Catron	[2] 3	[2] 165	[2] 31	[2] $1,085	[2] 2,503	[2] $3,201
Eddy	(2)	(2)	(2)	(2)	(2)	(2)
Grant	11	7,316,229	4,568	159,880	139,781	178,797
Hidalgo	3	126,526	3,119	109,165	112,590	144,016
Sandoval	1	6	1	35	237	303
Sierra	5	79	82	2,870	841	1,076
Socorro	2	284	4	140	523	669
Valencia	(2)	(2)	(2)	(2)	(2)	(2)
Total:						
1963	25	7,443,289	7,805	273,175	256,475	328,062
1962	22	7,687,345	7,529	263,515	301,549	327,181

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Catron	(2 3)	[2] $277	(2 3)	[2] $54	(2)	(2)	[2] $4,617
Eddy	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Grant	81,113	49,965,700	960	207,403	12,929	$2,973,704	53,485,484
Hidalgo	1,915	1,179,271	48	10,228	8	1,863	1,444,543
Sandoval							338
Sierra	2	1,047	(3)	32	(3)	12	5,037
Socorro	7	4,497	6	1,307	1	161	6,774
Valencia	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Total:							
1963	83,037	51,150,792	1,014	219,024	12,938	2,975,740	54,946,793
1962	82,683	50,932,728	1,134	208,656	22,015	5,063,450	56,795,530

[1] Does not include tonnage of precipitates shipped or gravel washed.
[2] Production of Catron, Eddy, and Valencia Counties combined to avoid disclosing individual company confidential data.
[3] Less than 0.5 ton.

TABLE 17.—Mine production of gold, silver, copper, lead, and zinc in 1963, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold	1	58	82	588	2,400	100	
Dry gold-silver	3	47,679	1,258	72,930	1,135,100	95,200	
Dry silver	3	27	1	318	600		
Total	7	47,764	1,341	73,836	1,138,100	95,300	
Copper	10	7,168,769	6,418	106,782	100,155,700	400	49,600
Lead	1	51	4	112	100	11,700	1,200
Lead-zinc	2	21		18		1,100	500
Zinc	3	187,486	40	73,551	311,200	1,888,600	25,796,500
Total	16	7,356,327	6,462	180,463	100,467,000	1,901,800	25,847,800
Other "lode" material:							
Copper precipitates	5	39,084			64,468,500		
Lead-zinc cleanup	(2)	114	2	2,176	400	30,900	28,200
Total	5	39,198	2	2,176	64,468,900	30,900	28,200
Total "lode" material	25	7,443,289	7,805	256,475	166,074,000	2,028,000	25,876,000

[1] Detail will not necessarily add to totals because some mines produce more than one class of material.
[2] From properties not classed as mines.

TABLE 18.—Mine production of gold, silver, copper, lead, and zinc in 1963, by types of material processed and methods of recovery, in terms of recoverable metals

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Concentration and smelting of concentrates: Ore	6,458	179,751	100,318,800	1,889,500	25,846,300
Direct-smelting:					
Ore	1,347	76,724	1,183,700	138,500	29,700
Copper precipitates			64,468,500		
Total	1,347	76,724	65,652,200	138,500	29,700
Leaching of copper ore			103,000		
Grand total	7,805	256,475	166,074,000	2,028,000	25,876,000

The market price for copper remained firm throughout the year at 30.8 cents per pound.

Kennecott Copper Corp. completed and continued to work on multi-million-dollar projects at the Chino open-pit mine and at the Hurley mill and smelter.

The Banner Mining Co. further developed and explored the Bonney-Miser's Chest mine, Hidalgo County.

Gold.—Gold production was 7,805 ounces. Five mines, Bayard (Continental) and Chino in Grant County and Bonney-Miser's Chest, Eighty-Five, and Henry Clay in Hidalgo County, produced 98 percent of the State gold. More than 82 percent of the gold output was recovered as a byproduct of copper ore from Bayard (Continental), Bonney-Miser's Chest, and Chino mines; the balance came primarily

from the gold-silver ore produced at the Eighty-Five and Henry Clay mines. Twelve operators working 11 mines in 6 counties contributed to the total gold produced.

Iron Ore.—Magnetite, from Socorro and Grant Counties, containing 60 to 65 percent iron, increased substantially over that of 1962. About 63 percent of the ore was sized and concentrated before shipment; the remainder was sold direct. The ore was used mostly as a high-density concrete aggregate. Mathis & Mathis at the Kearney mine in Grant County mined and shipped magnetite ore.

A recent information circular[9] of the Federal Bureau of Mines reported iron deposits (118 occurrences) in 21 counties; an extensive (iron) taconite potential area was reported in Rio Arriba County.

Lead.—Although declining for the 2d consecutive year, lead tonnage registered a small value increase. Output of lead was 1,014 tons. The Hanover and Linchburg mines owned by The New Jersey Zinc Co. and the Oswaldo mine leased by The New Jersey Zinc Co. from Kennecott Copper Corp. were idle for most of the year, thus greatly accounting for the decrease in production.

Although lead was recovered from ores produced at 11 operations in 5 counties, 945 tons of the State total production was derived from zinc ores produced at 3 Grant County mines. The Kearney mine, near Hanover, operated by American-Peru Mining Co., had the largest production, accounting for 89 percent of the State lead output.

Developments at the Kearney mine included several thousand feet each of raises, drifts, and exploration-hole drilling. The Linchburg mine, Socorro County, idle since November 1961, was activated in December 1963 for a production of 75 tons of lead ore per day.

Improvement of lead-market quotations from 10 to 12.5 cents per pound was the principal reason to operate and to reactivate other mines.

Manganese Ore.—Output of ferruginous manganese ore containing 12 percent manganese and 35 percent iron was mined by Luck Mining Co. from the Boston Hill mine, Grant County, and shipped to The Colorado Fuel and Iron Corp. (CF&I) steel plant at Pueblo, Colo.

Stockpiled manganese ore, crushed and sized, and blended to grade, was shipped from Socorro County by L. A. Goret & Valente Aguilar; it was shipped to Henderson, Nev. The Black Canyon mine, near Socorro, was rehabilitated during the 4th quarter of 1963 for production by Goret & Aguilar.

Molybdenum.—Both quantity and value of molybdenum production were 87 percent of those for 1962. Molybdenite concentrate was produced by Kennecott Copper Corp. in the Chino concentrator at Hurley, Grant County, as a byproduct of copper ore concentrate. This byproduct recovery accounted for most of the molybdenum produced in the State. At the Questa mine of Molybdenum Corporation of America, Taos County, a small quantity of molybdenite was produced for the first time since 1961. This was the State only molybdenum mine. Exploration and development were increased at the Questa mine.

Silver.—Although silver production decreased 15 percent, the value remained about the same as in 1962 owing to an increase in average

[9] Harrer, C. M., and F. J. Kelly. Reconnaissance of Iron Resources in New Mexico. BuMines Inf. Circ. 8190, 1963, 112 pp.

price from $1.085 per ounce in 1962 to $1.279 per ounce in 1963. The decreased quantity was caused principally by part-time idleness at the Hanover and Oswaldo mines. The decrease was partly compensated for by increased production from the Kearney mine and the Bearup mine of Thomas Consolidated Mines, Inc.

Leading silver producing mines in order of output were the Kearney and Chino, Grant County; Eigthy-Five, Bonney-Miser's Chest, and Henry Clay, Hidalgo County; and Bayard (Continental), Grant County, cumulatively accounting for 96 percent of the total output. Twenty-nine percent of the silver was obtained from silver and gold-silver ores, an equal amount from lead-zinc and zinc ores, and 42 percent from copper ores.

The higher price for silver caused interest in past silver-producing areas in several counties of the State.

Uranium Ore.—The State continued as the Nation's leading producer of uranium ore, a position held for the 5th consecutive year. Ore mined and milled was 34 percent less and output value 35 percent less in 1962. The decrease was a direct result of the reduction in the AEC procurement program for uranium oxide. It was brought about largely by the shortening of major-producing companies mine-mill work weeks.

Uranium ore was mined at 68 operations in 5 counties: McKinley, 52; San Juan, 8; Valencia, 6; and 1 each in Santa Fe and Socorro. McKinley County had an increase of 1 operation and Valencia and Socorro a loss of 1 each. The average weighted grade of uranium ore produced was 0.22 percent compared with 0.23 percent in 1962.

TABLE 19.—Summary of uranium concentrate plants

Company	Location of mill	Contract-expiration date	Tons U_3O_8 deliverable under contract from Jan. 1, 1963
The Anaconda Company	Grants	Dec. 31, 1970	[1] 6,046
Homestake-Sapin Partners [2]	do	Dec. 31, 1966	12,524
Kermac Nuclear Fuels Corp.	do	Dec. 31, 1966	9,986
Vanadium Corporation of America [3]	Shiprock	Dec. 31, 1966	1,768

[1] Contract extended through 1970.
[2] The Homestake-Sapin Partners mill is toll-treating ores formerly tributary to the Phillips Petroleum Co. mill which was acquired by United Nuclear Corp. in March 1963 and shut down.
[3] Shiprock mill acquired by VCA from Kerr-McGee Oil Industries, Inc., in February 1963. VCA Durango, Colo., mill was subsequently shut down and ores formerly tributary to Durango were being treated at Shiprock.

Source: U.S. Atomic Energy Commission. Annual Report to Congress for 1963. January 1964, p. 38.

Multimillion-dollar transactions were made in the State uranium industry: early in the year Vanadium Corporation of America (VCA) purchased Kerr-McGee Oil Industries, Inc., Navajo-Shiprock 15,000-ton-per-month mill and related uranium mines; United Nuclear Corp. acquired the Phillips Petroleum Co. 1,725-ton-per-day mill near Grants and a number of uranium-mine properties in the Ambrosia Lake district; and United Nuclear Corp. and Homestake Mining Co. consolidated properties, including Phillips, with that of Homestake-Sapin Partners (65 percent owned by United, 35 percent by Homestake).

Vanadium.—Twenty-three short tons of vanadium was recovered as a byproduct of uranium ores. The vanadium was recovered at processing plants located in the State and in Colorado.

Zinc.—Zinc production was 41 percent less than that of 1962. The leading producing mine was the Kearney in Grant County, which accounted for 83 percent of the State total zinc. The principal cause for the decreased zinc production was the closing of the Hanover and Oswaldo mines from December 1962 to November 1963.

REVIEW BY COUNTIES

Minerals were produced in 31 of the 32 counties; Torrance County reported no production. The 10 leading counties, in descending order of mineral-output value, were Lea, Eddy, San Juan, Grant, McKinley, Chaves, Rio Arriba, Roosevelt, Bernalillo, and Valencia.

Bernalillo.—All commodities increased in volume and value of output; stone showed 100-percent increase. Production of gypsum was not reported. Ideal Cement Co. operated its Tijeras plant throughout the year, showing an increase in production.

Sand and gravel was produced from 10 operations. Albuquerque Gravel Products Co., Springer Transfer Co., Inc., and other contractors for the State highway department were the principal producers. Miscellaneous stone was quarried at three operations. Kinney Brick Co., Inc., and Ideal Cement Co. continued to mine the bulk of the State output of miscellaneous clay; the increase in value output was 1 percent. Clay was used for brick and in manufacturing cement.

Scoria for use in manufacturing building block and associated products was mined by Edgar D. Otto & Son, Inc., from the Blackbird mine. Scoria output resulted in an 8-percent gain in production.

American Gypsum Co. expanded plant facilities to increase annual production from 100 million to 150 million square feet of gypsum wallboard. Total cost of the project was $1 million. Another plant expansion was planned for completion in 1964.

Catron.—Sand and gravel accounted for three-quarters of the production values. The principal commercial sand and gravel operator was Allison & Haney, Inc. Rocky Mountain Salt Co., near Quemado, produced salt from its solar-evaporation plant. Production of gold and silver and associated minerals was reported from the Bearup mine, near Glenwood, by Thomas Consolidated Mines, Inc. Collection of agate and petrified wood,. by Lee C. Winters, gem socities, and various other collectors, increased 120 percent.

Chaves.—Production increased 17 percent in value with petroleum accounting for 93 percent of the total $16 million production. Petroleum production from 763 wells, a gain of 6 wells, was 5.2 million barrels, or 14 percent greater than that of 1962. Natural gas was recovered from six wells, three more than in 1962. Of 23 development wells drilled, 16 were successful. Of eight sand and gravel operations, the principal commercial producers were Armstrong & Armstrong and J. W. Jones Construction Co. Miscellaneous stone was used in highway projects. Quartz crystals and selenite-rose specimens were collected for the gem stone markets.

TABLE 20.—Value of mineral production in New Mexico, by counties

County	1962	1963 [1]	Minerals produced in 1963 in order of value
Bernalillo	$7,489,578	$10 219,570	Cement, sand and gravel, stone, clays, pumice.
Catron	54,276	97,648	Sand and gravel, salt, silver, gem stones, gold, lead, copper.
Chaves	[2] 13,779,153	16,087,146	Petroleum, sand and gravel, natural gas, stone, gem stones.
Colfax	2,416,820	1,932,066	Coal, sand and gravel, stone.
Curry	342,796	(3)	Stone, sand and gravel.
De Baca	163,100	(3)	Sand and gravel, stone.
Dona Ana	821,669	543,328	Sand and gravel, stone, pumice, clays, gem stones.
Eddy	[2] 129,428,221	145,582,319	Potassium salts, petroleum, natural gas, natural gasoline, LP gases, salt, sand and gravel, stone, gem stones, copper, silver.
Grant	56,651,818	55,760,360	Copper, zinc, molybdenum, sand and gravel, lime, manganiferous ore, lead, silver, gold, stone, iron ore, gem stones.
Guadalupe	----------	399,000	Sand and gravel.
Harding	242,253	169,356	Sand and gravel, carbon dioxide (natural).
Hidalgo	2,064,713	1,533,400	Copper, silver, gold, sand and gravel, lead, clays, gem stones, zinc.
Lea	[2] 292,290,604	302,639,042	Petroleum, natural gas, natural gasoline, LP gases, potassium salts, stone, sand and gravel.
Lincoln	59,917	29,122	Sand and gravel, stone, pumice.
Los Alamos	----------	143,000	Sand and gravel.
Luna	52,141	180,141	Sand and gravel, gem stones, clays, stone.
McKinley	54,284,510	37,358,297	Uranium ore, sand and gravel, coal, petroleum, stone, vanadium, clays.
Mora	47,600	70,000	Sand and gravel.
Otero	176,090	558,769	Sand and gravel, stone.
Quay	727,300	627,500	Stone, sand and gravel.
Rio Arriba	[2] 11,388,921	13,067,304	Natural gas, petroleum, LP gases, sand and gravel, natural gasoline, pumice, mica (scrap), stone, coal, gem stones.
Roosevelt	[2] 15,486,013	10,898,548	Petroleum, natural gas, LP gases, natural gasoline, sand and gravel, stone.
Sandoval	525,343	1,461,329	Sand and gravel, gypsum, pumice, petroleum, coal, silver, gold.
San Juan	[2] 74,198,643	77,112,108	Natural gas, petroleum, LP gases, natural gasoline, helium, coal, sand and gravel, uranium ore, vanadium, stone.
San Miguel	184,277	(3)	Sand and gravel, stone.
Santa Fe	926,173	1,545,534	Sand and gravel, pumice, gypsum, uranium ore, stone.
Sierra	45,774	412,037	Sand and gravel, gold, gem stones, silver, copper, lead, zinc.
Socorro	157,380	1,004,232	Sand and gravel, stone, manganese concentrate, iron ore, barite, copper, lead, gem stones, silver, uranium ore, zinc, gold.
Taos	2,271,607	1,916,857	Perlite, mica (scrap), sand and gravel, molybdenum, gem stones.
Torrance	(3)	----------	
Union	292,232	(3)	Pumice, sand and gravel.
Valencia	(3)	(3)	Uranium ore, sand and gravel, perlite, stone, gem stones, copper, silver.
Undistributed [4]	[2] 12,298,098	8,879,151	
Total [5]	[2] 675,814,000	686,822,000	

[1] Petroleum value is preliminary.
[2] Revised figure.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Includes some scrap mica (1962) and gem stones that cannot be assigned to specific counties and values indicated by footnote 3.
[5] Total adjusted to eliminate duplicating value of marketed potassium compounds.

Colfax.—The mineral production decline was caused by drops in output of sand and gravel and stone. Coal production increased 16 percent and accounted for 93 percent of the value of mineral output. Coal was mined from three operations, one less than in 1962. The increase in coal output resulted mostly from greater production at the Koehler mine, operated by Kaiser Steel Corp. The coal was washed at the plant, and 95 percent of the output was shipped by rail to California for use at the company Fontana steel plant. In Septem-

ber, Kaiser Steel Corp. opened its York Canyon coal mine in the Raton area to develop a bed of coal for experimental purposes; coal, in excess of 200,000 tons, was stockpiled at the mine and then truck-hauled to Koehler for rail shipment to Kaiser's Fontana plant for blast furnace tests. The Rodman Coal Co. and Julius Seidel each reported increases in coal output.

Dona Ana.—Mineral production decreased 34 percent mainly because of lower sand and gravel output. Output values of miscellaneous stone and gem stones gained. Volcanic cinders (54,000 tons) were mined by Associated Materials Co., Builders Block & Supply Co., Inc., and Volcanic Cinder Co. for use mostly as a concrete aggregate for building. El Paso Brick Co. produced clays. Sand and gravel was produced by one Government-and-contractor and seven commercial operators. Atlas Land Co., Inc., and Burn Construction Co., Inc., were the principal commercial producers. Miscellaneous stone was quarried by Hugh McMillan, Inc., a contractor of the U.S. Army Corps of Engineers.

Eddy.—Potash mining and refining continued to be the principal activity in the mineral industry of the Carlsbad area. Potash production, increasing 20 percent, represented more than 50 percent of the county mineral wealth. Mines and refineries were operated by Duval Corp., International Minerals & Chemical Corp. (IMC), Potash Company of America, Southwest Potash Corp., and United States Borax & Chemical Corp. (U.S. Borax).

Major refinery improvements recently completed or nearing completion were principally to facilitate the processing of langbeinite ores.

In February, IMC completed a $1 million expansion and improvement project at the refinery for processing langbeinite ore; installed a new $130,000 bag-and-storage facility; and completed installing a $100,000 air-separation plant. The mine had an unusual rail-belt haulage system. In November, the company completed developing a block of ore to be longwalled early in 1964; a cooperative research program to instrument the longwall was conducted by the company and the Federal Bureau of Mines.

Potash Company of America completed a $5 million plant modernization project, which included conversion from salt to potash flotation. The continuous mining machine, designed and built by the company to operate in low-beds, was placed in service during November.

U.S. Borax completed projects costing several million dollars; these were the installation of crystallizer units and screening equipment at the refinery and mining equipment for the mines.

Duval Corp. continued work on projects totaling $8 million. The projects consisted of sinking and developing the new Nash Draw potash mine and installing a new langbeinite-process unit near the Saunders refinery. The Nash Draw mine shaft, 13 miles south of the Saunders mine, was prepared for freezing operations during the latter part of 1962, shaft-sinking operations did not commence until March 1963. Mine production was scheduled for the 4th quarter of 1964.

Southwest Potash Corp. continued with new expansion and modernization projects at the refinery.

National Potash Co., through Winston Bros. (contractor), commenced freezing operations in January at the company new Eddy mine shaft, a $3 million project. The ground was frozen to a depth of 350 feet before shaft-sinking was begun. The potash bed was intersected at the 700-foot level. Potash-ore production, anticipated by August 1964, was to be shipped by railroad to the company Lea mine refinery for blending and processing.

Tailings from the potash refineries were purchased and reprocessed, and the salt sold to stock dealers, oil-well drilling companies, highway and street departments, and other local consumers.

The county was ranked second in the State in producing petroleum and fourth in natural gas. Petroleum was produced from 3,916 wells, 118 more than in 1962. Natural gas was produced from 85 wells, a gain of 20 wells. Of 27 exploratory wells completed, 23 (10 oil and 13 gas) were successful. Of 143 development wells completed, 93 oil and 9 gas wells were successful.

Gasoline, butane, and propane were recovered at six natural gas plants. Throughput was 20.7 billion cubic feet of gas, with recovery of 979,700 barrels of natural gasoline, 205,600 barrels of butane, and 477,400 barrels of propane; 14.2 billion cubic feet of residual gas was marketed through pipelines. Phillips Petroleum Co. and Pan American Petroleum Corp., in the Artesia area, each recovered byproduct elemental sulfur.

Sand and gravel was produced at one Government-and-contractor and three commercial operations. The producers were the Carlsbad Transit Mix Cement Co., Inc., Floyd E. Sherrell & Sons, Potash Sand Co., and a contractor of the New Mexico State Highway Commission. Production of crushed limestone, used principally for highway construction, declined slightly from that reported for 1962.

The county was second in the State in output of gem stones, a fivefold gain; stones collected were agate, onyx, and turquoise. The principal individual producers were Vernon E. Wyrick and Andy's Rockery and Hobby.

The Jessie Lee mine of T. F. Hanna, Artesia, reported a shipment of copper ore.

On August 1, the AEC postponed the Project Coach detonation at Carlsbad. Preparations for the detonation have been underway since the completion of work on Project Gnome. In October the site and facilities were placed on a standby basis to await the outcome of developing a suitable neutron-producing nuclear device. A report covering the methods and costs of shaft sinking at Project Gnome was published by the Federal Bureau of Mines.[10]

Grant.—A drop of nearly $1 million in the value of minerals produced resulted chiefly from a $2.1 million decline in value of zinc output. Copper supplied $50 million or 90 percent of the value of mineral production. The output of sand and gravel increased significantly compared with that in 1962.

The Chino open-pit copper mine, in the Central district of Santa Rita, operated by the Chino Mines Division of Kennecott Copper

[10] Howes, Merwin H. Methods and Costs of Shaft Sinking, U.S. Atomic Energy Commission Project Gnome, near Carlsbad, N. Mex. BuMines Inf. Circ. 8195, 1963, 49 pp.

Corp., produced nearly all of the State output of copper; gold, silver, and molybdenum were recovered as byproducts. In its annual report the company stated that the total copper production from all sources at Chino was 80,629 tons in comparison with 73,683 tons in 1962; precipitate copper recovered gained 12.7 percent. The 6,648,058 tons of ore mined and milled (compared with 7,071,800 tons in 1962) averaged 17.6 pounds of copper per ton (18.2 pounds in 1962). Major improvements either completed or in progress included a $1 million project at the Hurley mill and a $2 million conversion from rail to truck haulage at the Chino pit. A $6 million expansion program, announced by the company late in 1963, was to expand copper production by 21,000 tons per year, or 24 percent.

The Kearney mine of American-Peru Mining Co. was the major source of zinc ore. Exploration and development projects included 14,000 feet of raising, 21,000 feet of drifting, and 15,000 feet of drilling.

The New Jersey Zinc Co. Hanover mine and the Oswaldo mine, leased by New Jersey Zinc from Kennecott Copper Corp., zinc producers, suspended operations December 1, 1962; mine production was not resumed until November 1, 1963.

The United States Smelting Refining and Mining Co. Bayard (Continental) mine, ranked second in copper production in the State, produced ore throughout the year; all ore was processed at the company 600-ton-per-day flotation mill near Bayard. The mine was operated through a lease agreement with the company by L. A. Patten and Associates. The company rehabilitated the Princess shaft mine, a zinc producer near Bayard. Other company-leased mines included the Zuniga mine, operated by Zuniga Mines, Inc., until May when lease was sold to and operated by T&E Mining Co., Bayard, early in 1963, and the Blue Bell and Modoc mines operated intermittently by Howard A. Wilmeth of Silver City. At each of the operations oxidized copper ores were vat-leached.

David Osmer leached copper ore in place at the Austin Amazon mines. The Liberty Bell and Copper Mountain mine, near Tyrone, produced copper precipitate from vat-leaching. Development and exploration work was progressing at the Copper Leaching Corp. Ohio-Thompson mine near Tyrone and at the Sleeping Beauty Mining Co. Sleeping Beauty mine near Cliff. Lead-zinc concentrate and copper ore were shipped from the Bishop mine near San Lorenzo. Eugene Bruell sold 114 tons of lead-zinc cleanup concentrate from the Hornet mill near Hachita.

Copper precipitates, in addition to that produced at the Chino operation, were sold by 12 operators who recovered copper from the water of Santa Rita Creek, downstream from the Chino operation.

From the Kearney mine, Mathis & Mathis produced 543 long tons of iron ore (magnetite) which was used mostly as an aggregate in making cement. The Luck Mining Co. shipped manganiferous ore from the Boston Hill mine near Silver City to the CF&I plant at Pueblo, Colo.

Nonmetal production accounted for approximately $1.2 million of the county total. The output of lime by Kennecott Copper Corp. declined 6 percent in comparison with that of 1962.

Sand and gravel output, increasing from $68,300 to $777,000, was produced mostly for use in highway construction by contractors of the Federal Forest Service and the New Mexico State Highway Commission. Building and fill sand and gravel was produced by Horace L. Bounds, Jr., Elgin Block Co., and M&M Sand & Gravel Co. Limestone output, 66,400 tons, a 10-percent gain, was quarried by Kennecott Copper Corp. The limestone was used in manufacturing lime and as a smelter flux.

Elgin Block Co. near Silver City continued producing lightweight aggregate concrete blocks. Reese Mining and Manufacturing Co. of Silver City was planning additional development projects at its clay mine and construction of a brick-manufacturing plant.

Harding.—Carbonic Chemicals Corp., Schwartz Carbonic Co., and R. W. Adams produced all of the State 854.3 million cubic feet of carbon dioxide gas. J. W. Jones Construction Co. was the only producer of sand and gravel which was used for road projects.

Hidalgo.—The Bonney-Miser's Chest mine of Banner Mining Co. was the State's third largest copper producer. According to the company annual report the mine produced 78,990 tons of ore, a decline of 16,280 tons compared with the 1962 output. The metal content of 6,049 tons of concentrate produced from ores beneficiated at the Bonney mill was 1,892 ounces of gold, 42,151 ounces of silver, and 2,776,743 pounds of copper. The Bonney shaft was deepened 107.6 feet, and a shaft station excavated at the 1,810-foot level. This was the greatest operating depth in the Lordsburg mining area. Exploration and development projects included 2,457 feet of crosscutting and drifting, 161 feet of raising, 206 feet of winzing, 5,186 feet of diamond drilling, and 925 feet of churn and long-hole drilling.

The Henry Clay mine owned by Werner Lake Nickel Mines, Ltd., operated under Henry Clay Mines, Inc., produced 16,353 tons of gold-silver ore, also containing copper and lead. The siliceous ore was shipped to the American Smelting and Refining Co. El Paso, Tex., and Hayden, Ariz., copper smelters.

In addition to the Bonney-Miser's Chest, Eighty-Five, and Henry Clay mines—which accounted for 94 percent of the county mineral wealth—four other mines were being developed: the Chester Durham & John W. Miller Blue Hill and 3–Js mines; the Frecor Copper Co., Ltd., Happy Promise No. 1 mine; and the Diversified Mines, Inc., Venus mine.

One commercial operator in addition to contractors of the State highway commission produced all of the sand and gravel output, 80,000 tons, used principally for highway projects. Phelps Dodge Corp. continued to mine fire clay for use at company smelters and for resale.

Jasper and agate gem stones were collected by Southwest Gems.

An OME contract betwen the Government and Henry Clay Mines, Inc., remained active, but only a minor amount of exploration was accomplished.

Lea.—The county let the State in petroleum production and the Nation in the mineral value of oil and gas output.[11] In the mineral fuels group Lea County accounted for 53 percent, $11.5 million, of the

[11] New Mexico Commerce and Industry Review. Lea County Nation's Leading Oil and Gas Producer. January 1964, p. 2.

State liquid petroleum gases output value; 69 percent, $12.1 million, of natural gasoline and cycle products; 69 percent, $219.0 million, of petroleum; and 50 percent, $48.8 million, of natural gas. Output value of liquid petroleum gases gained 11 percent in comparison with that of 1962; natural gasoline and cycle products, 7 percent; natural gas, 2 percent; and petroleum, 2 percent. Output value of potassium salts increased slightly and that of stone more than doubled; however, sand and gravel production decreased 15 percent in comparison with that of 1962.

Petroleum produced from 10,032 wells, a gain of 425 wells, reached an output of 76.1 million barrels. The number of producing gas wells, increasing from 1,289 to 1,321, flowed 417.8 billion cubic feet. Exploratory drilling resulted in 103 completed wells, of which 17 oil and 9 gas were successful. Of the 358 development wells completed, 292 oil and 6 gas were successful. Gas was processed at 19 extraction plants. Throughput was 376.7 billion cubic feet of gas, with the recovery of 7.5 million barrels of natural gasoline, 4.8 million of butane, and 3.0 million of propane; 298.9 billion cubic feet of residual gas was marketed through pipelines. Two plants used 16.3 billion cubic feet of natural gas for producing 52.2 million pounds of carbon black; stocks were not included.

Continental Oil Co. completed a $1 million natural gasoline plant about 4 miles south of Maljamar. Continental Oil Co. planned to invest about $6.6 million in exploration, production, and marketing activities in the State.

Marathon Oil Co. began operating the newly erected $1 million gasoline plant on March 17; owners of the plant were Gulf Oil Corp., Marathon Oil Co., Pure Oil Co., Sinclair Oil Co., and several independent oil men. Shell Oil Co. had drilled its 1–BE Shell-Federal well, in the southwestern part of the county, to a depth of 17,895 feet, exceeding the State former drilling-depth record by 340 feet.

National Potash Co. continued to expand its mining and refinery potash operations in the Carlsbad area. The company anticipated potash production from its newly developed $3 million Eddy mine in August. The Eddy mine ore blended with the Lea mine ore was to be processed at the Lea refinery.

Kermac Potash Co. continued work on its $20 million mine and refinery projects. Construction of the 1,500-ton-per-day potash refinery, scheduled for completion early 1965, was awarded to Western-Knapp Engineering Co.; only a part of the storage facilities were completed. The service shaft, one of the largest and deepest rotary drilled mine shafts, completed by Bighole Drillers, Inc., for Kermac about midyear, was being equipped for use. By piloting with a 48-inch bit, enlarging to 124 inches for the first 935 feet and finishing to 1,650 feet with a 102-inch bit, the contractor completed the shaft in less than 165 days. This included placing a continuous 8-foot 8-inch inside-diameter steel liner from the surface to 935 feet and cementing a 7-inch annulus behind the steel.

Sand and gravel produced by the Lea County Concrete Co. and contractors of the State highway commission was used mainly for road projects.

Lincoln.—With no metals produced during the year, county output declined 51 percent in value compared with that of 1962. The output

value of pumice increased 32 percent. Sand and gravel production accounted for the preponderance of total mineral output. Stone production showed a noticeable decrease.

Luna.—Nonmetals accounted for the total output value of $180,141, a twofold gain compared with that of 1962. All of the commodities increased in production excepting gem stones which decreased 20 percent. Of the four sand and gravel operators, Armstrong & Armstrong and O'Kelleys Motor Transport were the principal producers. Mathis & Mathis produced fire clay from the Lucretia clay mine.

McKinley.—The county led the State in the production of uranium ore. Major producing companies included Kermac Nuclear Fuels Corp., Phillips Petroleum Co., Homestake-Sapin Partners, and Calumet & Hecla, Inc. A total of 52 operations produced 1.8 million tons of uranium ore during the year representing 79 percent of the State total production of uranium ore, a decrease in output of 37 percent compared with that of 1962.

United Nuclear Corp. announced on April 1 that it had purchased the uranium operations of Phillips Petroleum Co. in the Grants area for a reported $28 million. The company stated that the newly acquired Phillips mill was closed down and placed on a standby basis, and ore previously processed at the mill would be handled by the Homestake-Sapin Partners mill in which United Nuclear held 65-percent interest. The Anaconda Company (Bluewater), Homestake-Sapin Partners (Ambrosia Lake), and Kermac Nuclear Fuels Corp. (Ambrosia Lake) decreased production.

Sand and gravel produced at five commercial and six Government-and-contractor operations increased from $117,000 in 1962 to $2.4 million. Output by M. M. Sundt Construction Co., the principal commercial operator; crews of the Federal Bureau of Indian Affairs; and contractors of the State highway commission was used mainly on road projects.

Coal production increased from $1.2 to $1.3 million, a gain of 9 percent compared with that of 1962. It was produced from one underground and two strip mines. The producers were Navajo Tribal Enterprises, operating the Window Rock underground mine; The Pittsburg & Midway Coal Mining Co., operating the McKinley strip mine; and Sundance Coal Co., operating the Sundance strip mine. Petroleum output value decreased 8 percent, from $448,600 (1962) to $414,600 (1963). Petroleum production from 87 wells was 143,608 barrels, 8 percent less than in 1962. Of 26 exploration and development wells drilled, 2 wells (oil) were successful, and 3 wells were used as service wells.

Crushed limestone was produced by New Mexico Materials Co. and Daniels Construction Co., a contractor of the New Mexico State Highway Commission, for use in road construction. Clay was mined by the U.S. Mining Corp. and sold for use as a drilling mud. A small quantity of vanadium was recovered from uranium processing plant solutions.

Rio Arriba.—Petroleum production from 252 wells was 28 percent above that of 1962. Natural gas production from 1,404 wells was 61.5 million cubic feet, a gain of 5 percent over that of 1962. Nine exploratory wells were completed, of which 1 oil well was successful; and of 174 development wells completed, 168 (28 oil, 140 gas) were successful.

Southern Union Gas Co. operated its natural gas plant at Lybrook. Throughput was 15.3 billion cubic feet of gas, from which 93,501 barrels of natural gasoline, 172,535 of butane, and 255,946 of propane were recovered, and 14.1 billion cubic feet of residual gas was marketed through company pipelines to consumers.

Coal was produced from the Rainbow mine operated by Carrillo Bros.

No hand-cobbed mica was mined in 1963, although scrap mica was mined by M.I.C.A., Inc., from its Joseph mine near Ojo Caliente and John W. Moran from the Blowout 1, 3, and 4 mines near Petaca. Scrap mica was beneficiated at the Pojoaque mill (Santa Fe County) operated by M.I.C.A., Inc., before shipment to markets. General Pumice Corp. continued to mine pumice from its Cullum mine.

Contractors and crews that worked for the Federal Bureau of Indian Affairs, Federal Forest Service, and the State highway commission produced 296,200 tons of sand and gravel principally for road projects. Stone was produced by James Hamilton Construction Co., Wayne Lowdermilk, and O. D. Cowart Contracting Co., contractors for the State highway commission, and by New Mexico Granite.

Roosevelt.—Petroleum production from 205 wells decreased 35 percent. A total of 15 exploratory wells was drilled and completed; 5 (3 oil and 2 gas) were successful. Of the 45 development wells completed, 43 oil wells were successful. Nearburg & Ingram operated its gasoline plant near Milnesand; throughput was 6.6 billion cubic feet of gas, from which 141,981 barrels of natural gasoline, 139,750 barrels of butane, and 191,373 barrels of propane were extracted. Residual gas, 4.3 billion cubic feet, was marketed through company pipelines.

Sandoval.—Construction materials, pumice, sand and gravel, and gypsum accounted for most of the mineral output. Increases in output value of coal, gypsum, pumice, and sand and gravel accounted for the nearly threefold rise in value in 1963 over 1962.

Sand and gravel (518,000 tons) was produced by Allison & Haney, Inc. and by contractors of the U.S. Army Corps of Engineers, Federal Bureau of Public Roads, and State highway commission. Gypsum was mined by Duke City Gravel Products Co. and White Mesa Gypsum Co. It was used principally for building materials. Pumice was produced by the Big Chief Mining Co. at its Big Chief mine.

Coal production was from the Padilla underground mine. Petroleum was produced from 16 wells, the same number as in 1962, and output was down 27 percent.

Gold- and silver-bearing ore was shipped by Sam Hofheins from the Little Daisy mine in the Cochiti mining district.

San Juan.—Crude oil was produced from 1,523 wells, a gain of 72 wells in comparison to that of 1962. The number of producing gas wells increased from 4,291 to 4,516. Of the 37 exploratory wells that were completed, 3 were successful oil wells; of 201 development wells completed, 78 oil and 96 gas were successful. Natural gas was processed at the El Paso Natural Gas Co. San Juan plant, Southern Union Gas Co. Kutz Canyon plant, Graridge Corp. Farmington plant, and Continental Oil Co. plant which started processing in May. Gas intake at the plants was 301.5 billion cubic feet of gas, from

which 2.6 million barrels of natural gasoline, 3.1 million of butane, and 2.8 million of propane were recovered. Residual gas, 282.8 billion cubic feet, was marketed through pipelines.

The Federal Bureau of Mines operated the Navajo helium plant at Shiprock.

Coal produced for the first time from the Navajo strip mine operated by Utah Construction & Mining Co. was used at the Arizona Public Service Co. new Four Corners thermoelectric powerplant. The mine and powerplant were dedicated June 21. The Hogback No. 13 coal mine operated by George R. Simpson & Hollis L. Tate produced coal for open markets.

On March 1, VCA purchased Kerr-McGee Oil Industries, Inc., 15,000 ton-per-month Navajo uranium mill near Shiprock. VCA closed down its Durango and Naturita, Colo., uranium mills in favor of the new Shiprock mill.

Other minerals produced were sand and gravel from six operations, uranium ore from eight mines, and vanadium recovered from processing uranium ores.

Santa Fe.—Pumice was produced by Copar Pumice Co., Inc., from a deposit in the Espanola area and by Crego Block Co., Inc., from its La Cienega mine in the Santa Fe area. The James H. Rhodes & Co. mill near Santa Fe processed crude pumice which was shipped from Rio Arriba County. Kaiser Gypsum Co., Inc., mined crude gypsum adjacent to its Rosario wallboard plant.

Production of sand and gravel increased to nearly three times that reported in 1962. Most of the sand and gravel was produced by Kauffman Trucking Co. and contractors for the State highway commission.

Crude scrap mica mined at M.I.C.A., Inc., Joseph mine (Rio Arriba County) was processed at the company Pojoaque grinding mill in the Santa Fe area.

Sierra.—Sand and gravel represented 98 percent of the mineral value in the county and increased eightfold compared with 1962 value. Five sand and gravel operations (three commercial and two Government-and-contractor) produced all the sand and gravel. Agate and wonderstone were collected by gem stone societies and individuals.

Socorro.—Sand and gravel was produced by contractors who worked for the U.S. Army Corps of Engineers and the State highway commission. It was used for water diversion structures at Socorro and highway projects. Stone was produced by Armstrong & Armstrong and Brown Construction Co., contractors for the State highway commission, and by Universal Grading Co., Inc., contractor for the U.S. Army Corps of Engineers.

Screened manganese, blended to grade, was shipped from stockpiles to Henderson, Nev., by L. A. Goret & Valente Aguilar of Socorro. During the 4th quarter of the year, Goret & Aguilar rehabilitated the partnership Black Canyon (manganese) mine near Socorro. Manganese production from this mine was to start early 1964.

Dotson Minerals Corp. continued to produce and ship magnetite ore. J. D. Torres produced some lead ore from the Mistletoe mine near Magdalena and the Chamberlin Lease made shipments of cop-

per ore from the Waldo mine. The Linchburg mine, held under lease by L. A. Patten from The New Jersey Zinc Co. and located near Magdalena, was activated in December 1963, for production to start by early 1964.

A small quantity of uranium ore was shipped by R. H. Lummus from the Bonanza mine to the Homestead-Sapin Partners mill for processing.

The Elaine mine operated by A. B. Baca Mining and Milling (formerly A. B. Baca) produced 600 tons of barite, accounting for the State total output.

Except for gem stone societies, Gerald U. Greene, one of four individual gem collectors, collected the greatest quantity of gem stones, consisting of agate, fluorescent stones, and quartz.

Taos.—Perlite from the No Agua area and scrap mica from the Taos area accounted for 99 percent of the mineral output value of Taos County. A 16-percent drop in output value was due largely to a decrease in sand and gravel output value, from $503,100 to $12,000 in 1963.

Perlite was mined at open-pit mines operated by Great Lakes Carbon Corp., Johns-Manville Products Corp., and United Perlite Corp.; production and output value increased slightly over that reported for 1962. Mica-bearing ore was mined at a sericite deposit and transported to the M.I.C.A., Inc., Pojoaque mill (Santa Fe County) for processing. Los Compadres Mica Co. operated its mica mill near Ojo Caliente. Sand and gravel was produced by one commercial operator only, Nick Gonzales & Son.

Exploration and development increased at the Questa mine of Molybdenum Corporation of America. The delineation of the northeast mineralized zone, commenced in 1962, was continued. During the last half of 1963, an underground bulk sampling program was initiated and a 28-ton-per-hour surface bulk sampling-crushing facility was constructed. During December the construction of a 7.5-ton-per-hour molybdenite flotation pilot mill commenced. Mine employment was increased from 44 workmen on January 1 to 141 employees on December 31. Underground development and exploration included 2,660 feet of drifting, raising, and crosscutting. Exploratory drilling, surface and underground, consisted of 46,125 feet of diamond drilling, 16,845 feet of rotary drilling, and 2,138 feet of longhole drilling. The company planned in excess of $20 million projects for mill installation and underground and open-pit mining. A small tonnage of molybdenite was produced from sampling plants for shipment.

Valencia.—The total value of mineral production in the county decreased 23 percent below that of 1962. The AEC program to stretch out purchases of uranium ore led to a decrease of 27 percent compared with that of 1962. However, sales of stone increased 74 percent, and sand and gravel output value rose 95 percent in comparison with that of 1962. The value of gem stones collected, although small in total amount, gained nearly 300 percent, a total output value of $3,700. Pumice was not produced during the year.

The county was ranked second in the State in the production of uranium ore. Output was by The Anaconda Company, El Paso Nat-

ural Gas Co. (formerly Rare Metals Corporation of America), Mesa Mining Co., and Sutton & Moe at six operations.

Commercial sand and gravel contractors were M & J Sand & Gravel and Belen Sand & Gravel Co. who handled 104,000 tons of material; Government-and-contractor operations supplied 236,900 tons of sand and gravel for projects of the U.S. Army Corps of Engineers and the State highway commission.

United States Gypsum Co. operated its Grants perlite mine and grinding-screening plant, and the product was shipped to company-owned expanding plants outside the State.

Ultra Marbles, Inc., formerly All American Marble Co., opened its new $100,000 plant in June, and expected to start supplying a backlog of orders for decorative and building slab marble. The marbleized travertine was obtained from the Omission (quarry) mine.

Gem stones consisting of travertine and agate were collected by Lenhoff's Little Gem Shop and Rock Center of Southwest.

The Mineral Industry of New York

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the New York State Museum and Science Service for collecting information on all minerals except fuels.

By Stanley A. Feitler [1]

VALUED at $260 million, mineral production in 1963 was less than one-half percent below that of 1960, the record high year. Improved demand for most mineral products resulted in an 8-percent increase in value, compared with the 1962 value. The largest dollar increases were recorded for cement, sand and gravel, iron ore, salt, and petroleum, in decreasing order. Significant decreases in value were recorded only for stone, natural gas, and lime. New York continued to be a major producer of cement, sand and gravel, and stone, and to lead the Nation in value of salt and in tonnage and value of talc and wollastonite.

TABLE 1.—Mineral production in New York [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays----thousand short tons	1,397	$1,618	1,598	$2,186
Emery----short tons	4,316	71	6,732	119
Gem stones	(2)	10	(2)	10
Gypsum----thousand short tons	601	3,122	647	3,339
Iron ore (usable)----thousand long tons, gross weight	2,099	24,953	(3)	(3)
Lead (recoverable content of ores, etc.)----short tons	1,063	196	1,009	218
Natural gas----million cubic feet	4,262	1,198	3,962	1,169
Peat----short tons	14,400	113	21,358	178
Petroleum (crude)----thousand 42-gallon barrels	1,589	7,309	[4] 1,929	[4] 8,854
Salt----thousand short tons	4,456	32,236	4,782	34,228
Sand and gravel----do	29,447	31,346	37,381	37,274
Silver (recoverable content of ores, etc.) thousand troy ounces	19	21	20	25
Stone----thousand short tons	27,589	47,256	26,611	44,549
Zinc (recoverable content of ores, etc.)----short tons	53,654	12,340	53,495	12,304
Value of items that cannot be disclosed: Abrasive garnet, cement, lime, talc, titanium concentrate, and wollastonite	----------	79,183	----------	115,768
Total	----------	[5] 240,972	----------	260,221

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed."
[4] Preliminary figure.
[5] Revised figure.

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–1959 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

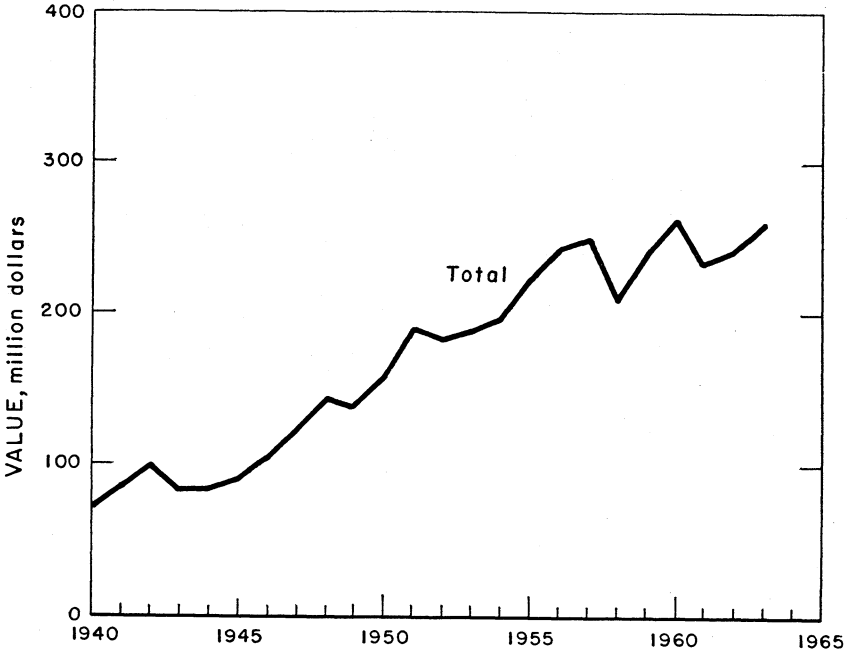


FIGURE 1.—Total value of mineral production in New York, 1940–63.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$212,515	1958	$207,087
1953	205,204	1959	235,987
1954	205,887	1960	257,272
1955	226,316	1961	231,507
1956	235,836	1962	239,135
1957	245,990	1963	257,109

Trends and Developments.—A nuclear fuels reprocessing plant was under construction near Springville in Erie County. This will be the first privately owned plant of its kind in the country. Consolidated Edison Co., New York City, withdrew its application for permission to build a nuclear-electric-powerplant in Queens. Niagara Mohawk Power Corp. announced plans for construction of a nuclear-fueled powerplant on Lake Ontario east of Oswego. Subject to the

approval by the Atomic Energy Commission, the plans provided for awarding construction contracts early in 1964 and for completion of the project in 1968.

International Nickel Co. began construction of a large metals research laboratory in Sterling Forest, Orange County. A metallurgy unit, Bard Hall, for both research and instruction was completed at Cornell University Campus, Ithaca.

Legislation and Government Programs.—The New York State Legislature enacted Article 3–A, Oil and Gas, of the Conservation Law. This article, effective October 1, 1963, regulates the issuance of drilling permits, notices to plug and abandon wells, and permits to conduct underground storage. It also provides that all pertinent well records be submitted in duplicate, a copy being furnished to the New York State Geologist. It further empowers the State Executive Department to issue leases on State lands other than parks; to aid operators of underground storage facilities to acquire needed rights through condemnation proceedings; to regulate well spacing in fields and in relation to other mining operations; and to control unitization, proration, and in general, act to conserve the oil and gas resources.

Water.—Adequacy of the Nation's water supply with respect to present and future requirements has become a problem of growing concern. To aid in understanding the problem, the Bureau of Mines canvassed the mineral industry in 1963 to obtain data on the use of water in 1962. This information has been presented by type of operation in table 3 for the State of New York.

The mineral industry treated 33 percent of all new water before use. The principal treatment processes were filtration, pH control, chlorination, and bacteria control. Most recirculated water (93 percent) was settled, and 18 percent was filtered before being reused. Prior to discharge 28 percent of the water was settled or otherwise treated and the remainder was discharged without treatment. Disposal of water was to streams and lakes, 81 percent; by surface seepage and well injection, 18 percent; and to sewers and to other users, 1 percent.

TABLE 3.—Water use by the mineral industry in 1962

(Million gallons)

Type of operation	New water	Recirculated water	Total water used	Discharged water	Consumed water
Quarries and mills	3,872	549	4,421	3,593	279
Metal mines and mills	1,822	8,286	10,108	1,565	256
Nonmetal mines and mills	7,561	287	7,848	6,402	1,160
Sand and gravel mines	6,917	2,254	9,171	6,504	413
Petroleum natural gas	1,462	----------	1,462	925	537
Total	21,634	11,376	33,010	18,989	2,645

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of all types of cement increased 22 percent in quantity and 12 percent in value, compared with those of 1962; the average value ($3.02 per barrel) was $0.27 per barrel less than the

1962 average. Portland, masonry, and natural cements were produced; portland cement accounted for 95 percent of the total value. Portland cement shipments were 23 percent higher than in 1962, but the average value was $0.28 per barrel less and the value increased only 13 percent. Masonry cement shipments were virtually the same in quantity as those of 1962, but the value decreased 3 percent. Natural cement shipments decreased 15 percent in quantity and 17 percent in value. Percentage utilization of capacity was significantly reduced by the addition of Atlantic Cement Co.'s 10-million-barrel plant in Albany County. Production was reported from 13 plants, 10 of which produced portland and masonry cements. Two plants produced portland cement exclusively, and one plant produced masonry and natural cements. Albany County assumed the lead in cement production with Greene County a close second. In decreasing order of value, other cement-producing counties were Columbia, Ulster, Erie, Warren, Schoharie, and Onondaga.

The principal raw materials for manufacturing portland cement were cement rock and limestone, of which a total of 5.9 million tons was used. In addition, the following tonnages of other raw material were consumed: Clay and shale, 335,000; gypsum, 173,000; sand and slag, 61,000; and iron materials, 21,000. Air-entraining compounds, grinding aids, fly ash, and bauxite also were used. The industry consumed 568 million kilowatt-hours of electrical energy of which 95 percent was purchased from public utility companies, and 5 percent was generated by recovering heat from stack gases.

More than half the total output of portland cement was consumed in New York State. Shipments of more than 1 million barrels were made to consumers in Connecticut, Massachusetts, and New Jersey; smaller quantities were shipped to 14 other States. Distribution of portland cement shipments by type of customer was as follows: Ready-mixed concrete companies, 71 percent; building material dealers, concrete products manufacturers, and highway contractors, 9 percent each; other contractors, miscellaneous customers, and Federal, State and local government agencies combined, 2 percent. Bulk shipments accounted for 85 percent of the total, and deliveries were by truck, 68 percent; railroad, 18 percent; and waterway, 14 percent.

Portland cement plant capacity, reported as 35.1 million barrels, was slightly higher than in 1962. Wet-process plants accounted for 70 percent of total capacity. Percentage utilization of capacity in the State was significantly reduced by the addition of the 10 million barrel per year plant of Atlantic Cement Co. Yearend stocks of portland cement were 14 percent higher than those of 1962.

The Catskill plant of Marquette Cement Manufacturing Co., Greene County, was being modernized by installation of new equipment capable of producing more than 3 million barrels of cement per year. Alpha Portland Cement Co., also near Catskill, had under construction a new 3-million-barrel-per-year plant to replace the existing 1.7-million-barrel plant. Hudson Cement Division, Colonial Sand & Stone Co., Inc., had near completion the installation of new equipment to increase the capacity of its Kingston plant to 4 million barrels per year.

Clays.—Output of miscellaneous clay and shale increased because of expanded production of building brick and lightweight aggregate. Fired clay lightweight aggregate was made at three plants in Ulster County, one plant each in Albany, Erie, and Onondaga Counties, and in Schenectady County at a plant completed during 1963. Output was shipped to consumers in the New York City area, eastern New York, and parts of New England. Consumption of miscellaneous clay and shale for the manufacture of building brick and cement was higher than that of 1962. The quantity of clay for art pottery, flower pots, and other uses was about the same as in the previous year. Albany slip clay, mined for many years in the Albany district, was used principally as a binder for artificial abrasive wheels and shapes and in art pottery. Production was reported by 22 companies operating 24 pits in 11 counties. The chief centers of clay production were in eastern and southeastern New York (Albany, Columbia, Orange, Schoharie, and Ulster Counties), central New York (Onondaga County), and western New York (Erie County).

Emery.—Sales of emery from three open pit mines in Westchester County increased substantially compared with those of 1962. Ore from three open pit mines was shipped to consumers in New York and Massachusetts. Part of the output was used for general abrasive purposes and the rest as aggregate for heavy-duty nonslip floors.

Garnet.—Sales of garnet produced in Essex and Warren Counties were greater than in 1962. Ground garnet used in coated abrasives, grinding and polishing glass, and metal lapping was produced from an open pit mine in Warren County. Garnet recovered at an underground operation in Essex County as a byproduct of wollastonite was used for sand blasting.

Gem Stones.—Except for the garnet produced commercially in Warren County, gem stones and mineral specimens were recovered principally by amateur mineral collectors.

Graphite (Manufactured).—Manufactured graphite was made from petroleum coke by Union Carbide Corp., Carbon Products Division, and Great Lakes Carbon Corp. in Niagara Falls. Products consisted of crucibles, electrodes, other finished shapes, and blanks that were machined to specification by the user.

Gypsum.—Reversing a 3-year downward trend, output of gypsum increased 8 percent in quantity and 7 percent in value compared with that of 1962. Gypsum was recovered at five underground mines—three in Erie County and one each in Genesee and Monroe Counties. Most of the crude gypsum was calcined at company-owned plants for use in manufacturing building material; some was used as a retarder in portland cement. Gypsum was calcined at seven plants located in Bronx, Erie, Genesee, Monroe, Richmond, and Rockland Counties. The major use for calcined gypsum was in the manufacture of wallboard and lath and in the formulation of various types of plaster; other uses were in manufacturing plate glass, pottery plasters, industrial molding, and art and casting plasters. New York ranked fifth in value of crude gypsum produced.

Lime.—Production of lime decreased 4 percent in quantity and value compared with that of 1962. Quicklime, which accounted for 95 percent of the total quantity of lime produced, was captive production for

TABLE 4.—Crude gypsum production

(Thousand short tons and thousand dollars)

Year	Active mines	Quantity	Value	Year	Active mines	Quantity	Value
1954-58 (average)	5	1,044	$4,169	1961	5	663	$3,441
1959	5	919	4,663	1962	5	601	3,122
1960	5	755	3,928	1963	5	647	3,339

chemical uses. Construction uses accounted for two-thirds of the hydrated lime output and chemical processing accounted for one-third. Ninety-five percent of all lime produced was captive production. Paper plants in Niagara and Essex Counties regenerated lime for use in paper manufacture.

Magnesium Compounds.—A small quantity of magnesium chloride was recovered as a byproduct of zirconium production at the Akron (Erie County) plant of Carborundum Metals Co., Division of The Carborundum Co.

Nitrogen Compounds.—E. I. du Pont de Nemours & Co., Inc., and Olin-Mathieson Chemical Corp. made fertilizers, explosives, and other chemical products from atmospheric nitrogen recovered in plants at Niagara Falls, Niagara County.

Perlite.—Crude perlite mined in Colorado, Oklahoma, and Nevada was expanded at six plants—three in Erie County and one each in Bronx, Genesee, and Onondaga Counties. The quantity produced decreased and the average value was $1.84 per ton lower than in 1962. Eighty-five percent of the output was used in acoustical building plaster; the remainder was used for loose fill insulation, ultra lightweight concrete aggregate, soil conditioning, filtering, and other uses.

Salt.—New York led the Nation in value of salt production and was third in tonnage. Evaporated salt, used in manufacturing chemicals and a wide variety of industrial and food processes as well as seasoning, had an average value of $23.28 per ton, $0.24 less than that of 1962. Rock salt with an average value of $5.57 per ton, $0.03 higher than in 1962, was used principally in manufacturing chemicals and for highway ice control. Salt in brine was used principally in the manufacture of chemicals. Brine containing salt and calcium chloride was applied to gravel and dirt roads as a stabilizer and for dust control. Salt was produced from wells in Onondaga, Schuyler, and Wyoming Counties; rock salt was mined in Livingston and Tompkins Counties. Most of the output was consumed in the Middle Atlantic States and New England.

TABLE 5.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954-58 (average)	3,731	$26,825	1961	4,149	$30,761
1959	4,011	30,958	1962	4,456	32,236
1960	4,008	30,763	1963	4,782	34,228

Sand and Gravel.—Production of sand and gravel increased significantly compared with that of 1962 largely because of better reporting of Government-and-contractor output. Commercial production increased 1 percent in quantity, but the average value decreased $0.04 per ton to $1.08 and the value was 2 percent lower. Total tonnage of industrial sand for molding, engine, filtration, and other uses decreased 12 percent, but the average value was $3.22 per ton—$0.23 higher than that of 1962. Output by Government-and-contractor operations consisted chiefly of paving and fill material used for road construction, maintenance, and repair.

Commercially produced material was transported to consumers by truck, 80 percent; waterway, 18 percent; and railroad, 2 percent. Bank run (unprocessed) sand and gravel amounted to 17 percent of the total output. Commercial production was reported from 335 operations of which 6 produced more than 1 million tons, 4 produced from 500,000 to 1 million tons, and 17 produced from 200,000 to 500,000 tons. Output of less than 25,000 tons was reported by 187 producers. Sand and gravel production was reported from 54 of the State's 62 counties; more than 1 million tons each was reported from Suffolk, Nassau, Erie, Monroe, Onondaga, and Cattaraugus Counties in descending order of tonnage.

Stone.—Stone continued to be the second most valuable mineral commodity in the State, although both tonnage and value were lower than in 1962. The decrease, though small, was general and affected most types of stone and most uses. More than 2 million tons of stone were produced in each of Dutchess, Rockland, Albany, and Onondaga Counties, in descending order of tonnage. Production of more than 1 million tons was reported in six other counties. Crushed limestone was used principally for concrete aggregate, roadstone, cement, and lime. Other uses included agstone (agricultural stone), asphalt filler, riprap, flux stone, and whiting. The leading counties for commercial limestone production were Dutchess and Onondaga. A small quantity of dimension limestone was produced in Onondaga and Washington Counties.

Production of basalt (traprock), the State's second ranking stone, decreased 3 percent in quantity and increased 6 percent in value as compared with 1962. Ninety-five percent of the tonnage produced was used for concrete and roadstone. Sixty-five percent of the basalt was delivered by waterway; most of the remainder was delivered by truck with only a negligible tonnage shipped by railroad. Sandstone was quarried and marketed as dimension stone as well as crushed stone and continued to rank third in tonnage and value. Output was 14 percent lower in quantity and 16 percent lower in value than that of 1962. Crushed sandstone, used for concrete, roadstone, and riprap was all delivered by truck. Dimension sandstone was used principally for flagging and building stone (sawed, dressed, and rough). Sandstone was mined for stone sand in Sullivan County.

Slate was mined and prepared for flagging, roofing, and structural use in Washington County. Production was substantially greater than in 1962. One producer marketed a quantity of crushed slate. Miscellaneous stone was mined and crushed in Clinton and Rensselaer Counties for use as concrete aggregate and roadstone. Marble was

TABLE 6.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	9,451	$11,231	9,125	$10,570
Paving	5,846	6,027	5,358	5,659
Fill	725	376	1,191	528
Molding	160	624	162	632
Filtration	(1)	(1)	19	25
Other	695	641	1,443	875
Undistributed [2]	104	165	52	95
Total	16,981	19,064	17,350	18,384
Gravel:				
Building	4,391	6,063	4,249	5,670
Paving	4,268	4,383	4,006	4,569
Fill	1,307	714	1,605	881
Undistributed [3]	592	603	641	601
Total	10,558	11,763	10,501	11,721
Total sand and gravel	27,539	30,827	27,851	30,105
Government-and-contractor operations: [4]				
Sand:				
Building	42	16	13	20
Paving	32	19	455	309
Fill	84	6	1,730	729
Other	319	137	386	166
Total	477	178	2,584	1,224
Gravel:				
Building	8	3	3	2
Paving	1,139	308	4,208	4,194
Fill	284	30	2,735	1,749
Other				
Total	1,431	341	6,946	5,945
Total sand and gravel	1,908	519	9,530	7,169
All operations:				
Sand	17,458	19,242	19,934	19,608
Gravel	11,989	12,104	17,447	17,666
Grand total	29,447	31,346	37,381	37,274

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes blast sand (1963), engine sand, and ground sand (1963), other industrial sand, and data indicated by footnote 1.
[3] Includes railroad ballast and other gravel.
[4] Includes data for State, counties, municipalities and other Government agencies.

TABLE 7.—Sand and gravel production by Government-and-contractor operations, by counties

(Short tons)

County	1962	1963	County	1962	1963
Cattaraugus	7,112		Onondaga	54,942	267,850
Cayuga	6,750	2,600	Ontario	84,172	64,634
Chautauqua	174,211	208,077	Orange	79,131	108,675
Chemung	6,500	11,340	Orleans	12,867	8,348
Clinton		90,000	Oswego	35,000	50,000
Columbia	4,490	32,835	Otsego	37,800	89,500
Delaware	13,270	2,002	Rensselaer	(1)	59,100
Dutchess	11,239	26,740	St. Lawrence	259,551	77,169
Essex	29,350	12,000	Saratoga	40,000	44,000
Franklin	134,052	89,027	Schenectady	39,697	33,213
Genesee	(1)	57,904	Schuyler	32,400	33,750
Hamilton	7,350		Seneca	23,294	
Herkimer	57,054	15,711	Steuben	(1)	115,900
Jefferson	58,965	10,139	Suffolk	68,067	32,670
Lewis	7,500	4,590	Washington	23,301	25,373
Livingston	12,320	12,400	Wayne	72,259	112,517
Montgomery		13,186	Undistributed [2]	452,955	7,795,900
Niagara	7,935	162			
Oneida	55,112	22,950	Total	1,908,646	9,530,262

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes data unspecified by counties and data indicated by footnote 1 in 1962.

mined in St. Lawrence and Westchester Counties for roadstone, terrazzo, stucco, and various other applications. Granite quarried and dressed in Westchester County was used for building stone. Crushed granite mined in Warren County was used principally for concrete aggregate and roadstone.

TABLE 8.—Crushed and broken limestone sold or used by producers by uses

(Thousand short tons and thousand dollars)

Use	1962		1963	
	Quantity	Value	Quantity	Value
Riprap	159	$272	209	$312
Concrete aggregate and roadstone	14,739	26,270	14,261	25,578
Fluxing stone	51	82	(1)	(1)
Agricultural	340	935	399	1,250
Railroad ballast	588	952	497	848
Cement and lime	5,930	5,782	7,214	5,851
Miscellaneous uses	2,021	3,619	535	1,563
Total [2]	23,827	37,913	23,115	35,402

[1] Included in miscellaneous uses total.
[2] Data may not add to totals shown because of rounding.

Talc.—Talc sold or used increased 9 percent in quantity and 14 percent in value as New York continued to be the leading talc-producing State. Two companies mined talc from three underground mines and one open-cut mine in St. Lawrence County. The crude talc was ground in company-owned mills and marketed principally for use in ceramics and paint. Ground talc also was sold for use as a lubricant and mineral pulp filler in various products.

Vermiculite.—Crude vermiculite mined in Montana and South Carolina was exfoliated at plants in Cayuga and Oneida Counties. The expanded material was used in acoustical and fireproofing plaster, ultralight-weight concrete, loose fill insulation, and agriculture.

Wollastonite.—Cabot Minerals Division, Cabot Corp., mined and ground wollastonite for use in ceramics, paint, plastics, fiber board, and other building products. Wollastonite mined and processed by Adirondack Development Corp. from its Lewis and Deerhead deposits was used for experimental purposes.

METALS

Aluminum.—Production of primary aluminum increased 11 percent in quantity and 5 percent in value compared with that of 1962. New York, with 9 percent of U.S. primary aluminum capacity, ranked fourth in output. The 100,000 ton-per-year aluminum rolling mill of Alroll, Inc., Oswego, was completed and breaking-in operations began in March; by late June the facility was operating at about 50 percent of capacity. Alroll, Inc., was organized by three United States and one Canadian company to supply their mills with coiled aluminum reroll stock.

Ferroalloys.—Shipments increased 20 percent to 108,038 tons and the value increased 18 percent to $23 million, compared with 90,000 tons and $19.7 million in 1962. Total shipments exceeded production by 6,000 tons resulting in an overall inventory reduction. Among the ferroalloys commonly produced in large quantities, silicomanganese, ferrosilicon, and ferrochromium and chromium briquettes were shipped in greater quantities than in 1962; ferromanganese, silvery pig iron, and ferrochrome silicon shipments decreased. New York ranked fourth in value of shipments of ferroalloys.

TABLE 9.—Ferroalloy producers in 1963

Company	Location	Type of furnace	Ferroalloys produced [1]
Hanna Furnace Corp	Erie County, Buffalo	Blast	Silvery pig iron.
Pittsburgh Metallurgical Co	Niagara County, Niagara Falls.	Electric	FeMn, SiMn, FeSi, FeCr, silvery pig iron.
Titanium Alloy Manufacturing Division of National Lead Co.	do	do	FeTi, FeB, FeZr.
Union Carbide Metals Co	do	do	FeCr, FeTi, FeW, FeB, FeCb FeCbTa, SiMn, FeSi.

[1] Symbols: FeMn, Ferromanganese; SiMn, Silicomanganese; FeSi, ferrosilicon; FeCr, ferrochromium; FeTi, ferrotitanium; FeW, ferrotungsten; FeB, ferroboron; FeCb, ferrocolumbium; FeCbTa, ferrocolumbium-tantalum; FeZr, ferrozirconium.

Iron Ore.—Mining was carried on at an accelerated rate and shipments of usable iron ore increased in tonnage and value as compared with those of 1962. Crude magnetite ore, recovered 83 percent by surface methods and 17 percent by underground mining, was beneficiated and shipped as concentrate (19 percent) and as sintered agglomerate (81 percent). Two mines were operated in Essex County and one each in Clinton and St. Lawrence Counties. A quantity of hematite was mined in Oneida County for use as iron oxide pigment.

Iron and Steel.—Steel production increased 14 percent over that of 1962 and totaled 5.4 million tons, according to the American Iron and Steel Institute. Open-hearth production represented 97 percent of the total; the remainder was electric furnace output. The State continued to rank seventh among the steel-producing States and supplied

5 percent of the national output. Production of pig iron was 4.3 million tons, 9 percent greater than in 1962. Shipments totaled 4.3 million tons valued at $290.2 million. Yearend stocks at blast furnaces were lower than at the end of 1962. Basic pig iron production predominated, but quantities of malleable, low phosphorous, foundry, and Bessemer, in decreasing order of tonnage, were produced. Pig iron was produced at 6 plants having 17 blast furnaces. At active plants, 2 of the 17 blast furnaces were out of blast the entire year.

Most of the iron ore shipped to the plants was of domestic origin; receipts were below that of 1962. Foreign ore receipts increased and came mostly from Canada. Other materials consumed in blast furnaces included limestone and dolomite, mill cinder and roll scale, coke, manganiferous ore, and scrap iron and steel. Slag and scrap produced at blast furnaces totaled 1.7 million tons and 48,000 tons, respectively. Recovered materials included 241,000 tons of flue dust.

Special Metals, Inc., New Hartford, Washington County, completed construction of a new vacuum induction furnace and began production of vacuum melted alloys. The new furnace, rated at 1,000-kilowatt input, required 3½ hours to run a 16,000-pound heat.

Republic Steel Corp. completed plans for continuing use of the oxygen lance steel making process and installation of air cleaning equipment to abate discharge of red dust to the atmosphere at its Buffalo plant.

Construction of a new oxygen steelmaking shop continued at the Lackawanna plant of Bethlehem Steel Co. In addition, extensive improvements were under way to modernize the strip mills, billet mills, and No. 3 open hearth shop.

Crucible Steel Co. completed plans for a new bar and rod mill to be installed at its Sanderson-Holcomb Works, Syracuse. Allegheny Ludlum Steel Corp. began construction of additional melting capacity at its Watervliet plant in Albany County to centralize production of bar products.

Construction of a continuous casting, steel melting plant was undertaken by Roblin-Seaway Industries, Inc., at Dunkirk. Steel scrap will be melted in electric furnaces to produce steel billets. Wickwire Spencer Steel plant of Colorado Fuel & Iron Corp., Buffalo, discontinued operations.

Lead.—Output of lead from the Balmat mine in St. Lawrence County decreased 5 percent in tonnage, but the price of metal was higher than in 1962 and value increased 11 percent. The ore was mined underground and beneficiated by flotation. Concentrate was treated at the company's lead smelter at Herculaneum, Mo.

Electric Auto-Lite Battery Corp. made black lead oxide in its Niagara Falls plant. National Lead Co. converted lead to red lead and litharge at its Brooklyn plant.

Silver.—Silver was recovered as a byproduct of lead-zinc ore from the Balmat mine in St. Lawrence County. The quantity recovered was about the same as that in 1962, but the average value of silver rose from $1.08519 per ounce in 1962 to $1.27912 in 1963 and the value was higher.

Titanium Concentrate (Ilmenite).—Ilmenite concentrate was recovered as a coproduct of magnetite from an open cut titaniferous-magnetite deposit near Tahawus, Essex County. Shipments and

TABLE 10.—Mine production of silver, lead, and zinc, in terms of recoverable metals

Year	Mines producing	Material sold or treated (short tons)	Silver		Lead		Zinc		Total value (thousands)
			Troy ounces	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	2	639,054	63,103	$57	1,216	$350	56,600	$13,309	$13,716
1959	2	438,769	51,588	47	481	111	43,464	9,997	10,155
1960	2	701,197	49,324	45	775	181	66,364	17,122	17,348
1961	2	592,438	40,507	37	879	181	54,763	12,595	12,813
1962	3	596,452	19,451	21	1,063	196	53,654	12,340	12,557
1963	3	594,245	19,544	25	1,009	218	53,495	12,304	12,547

TABLE 11.—Mine production of silver, lead, and zinc in 1963, by months, in terms of recoverable metals

Month	Silver (troy ounces)	Lead (short tons)	Zinc (short tons)	Month	Silver (troy ounces)	Lead (short tons)	Zinc (short tons)
January	1,970	105	4,314	August	1,785	91	4,880
February	1,849	96	4,682	September	1,273	66	3,922
March	1,875	95	4,744	October	1,308	70	4,966
April	1,408	70	4,964	November	1,596	85	4,101
May	1,908	95	4,515	December	1,818	97	4,011
June	1,426	72	3,950				
July	1,328	67	4,446	Total	19,544	1,009	53,495

value were 1 percent higher than those of 1962. The output was used principally in the manufacture of titanium dioxide pigment.

Zinc.—New York continued to rank third in the Nation, although zinc production was slightly lower than in 1962. The Balmat and Edwards mines in St. Lawrence County continued to be the only producers of zinc in the State. Plans were completed to expand the capacity of the Edwards mine and concentrating plant by 50 percent.

Zirconium.—Zirconia and zircon refractories were manufactured respectively by Harbison-Carborundum Corp., Falconer, Chautauqua County, and Corhart Refractories Co., Corning, Steuben County. Titanium Alloy Manufacturing Division, National Lead Co., produced various zirconium compounds in its plant near Niagara Falls.

MINERAL FUELS

Coke and Coal Chemicals.—New York ranked 8th in quantity and 7th in value among the 21 coke-producing States. Three companies operating one merchant and two furnace plants were active. The total number of slot ovens in use remained unchanged at 805. Allied Chemical Corp. produced coke and coal chemicals consisting of ammonia liquor, crude coal tar, crude chemical oil, and crude light oil. The crude light oil was further refined into benzene, toluene, and xylene at the company's Syracuse plant. Bethlehem operated 535 ovens at Lackawanna, mainly to supply its nearby blast furnaces. Donner-Hanna Coke Corp., jointly owned by Republic Steel Corp. and Hanna Furnace Co., produced coke and various coal chemicals in 150 ovens at its Buffalo plant. Construction of 50 additional ovens at the plant continued.

Slightly over 3 million tons of coke were consumed in New York. Ninety-three percent of the coke consumed was charged into blast furnaces; the remainder was used in foundries and other industrial plants and for residential heating. One hundred and eighty-nine thousand tons of coke breeze, the fines screened out of run-of-oven coke, were used for fuel.

Natural Gas.—Production of natural gas, though lower than that of 1962, was 2.9 times the quantity of new reserves discovered during the year. According to American Gas Association estimates, gas in underground storage increased 988,000 thousand cubic feet to a total of 91,385,000 thousand cubic feet and total reserves of native and storage gas amounted to 132,285,000 thousand cubic feet. Gas was stored underground by 5 companies in 15 fields located generally in the southwestern and western part of the State. The percentage of successful wildcat gas wells decreased from 34 percent of the total drilled in 1962 to 26 percent in 1963. Average depth of the successful gas wildcat wells was 2,400 feet, dry holes averaged 3,342 feet in depth. Formations explored for gas included the Silurian Medina sandstone and Oneida conglomerate, the Ordovician Queeston, Frankfort, and Theresa formations, and the Cambrian Potsdam formation.

Peat.—Increased production, shipments, and value of peat were recorded. Average value per ton increased from $7.85 in 1962 to $8.32 but was still below the national average of $9.92. The number of active operations increased to five compared with three in 1962. Output was reported, in decreasing order of tonnage, from Orange, Westchester, Cattaraugus, and Seneca Counties. Sales in bulk and packaged were for use in soil improvement, potting soils, seed inoculant, mushroom beds, and other applications. A recent survey indicated that known reserves of peat at active operations totaled 922,000 tons in 99 acres. Known reserves throughout the State totaled 480 million tons.[2]

Petroleum.—Production of crude oil in 1963 increased 21 percent compared with that of 1962. Wells in Allegany and Steuben Counties yielded 52 percent of the total; the remainder was from Chattaraugus County. As of January 1, 1963, the posted price was $4.63 per barrel for Cattaraugus crude and $4.55 per barrel for Allegany crude.[3]

The average yield of the State's estimated 13,100 oil wells was about 0.4 barrel per day. Output of crude oil in 1963 was 0.1 percent of the national total; since production began in 1859, New York wells have yielded 0.3 percent of all crude oil produced in the United States. As of December 31, 1963, the American Petroleum Institute estimated the New York reserves to be 18,435,000 barrels, reflecting production of 1,671,000 in 1963, and a 3,000,000 barrel downward revision of the previous estimate.

Oil well completions totaled 387 of which 245 were development wells and 142 service wells—no wildcat wells were drilled for oil in 1963. All drilling was by cable tool rigs; average depths were 1,167 feet for development wells and 1,035 feet for service wells.

---

[2] Geological Survey. Coal Resources of the United States (Progress Report). Circ. 293, Oct. 1, 1953, p. 38.

[3] Kreidler, W. Lynn. Gas and Oil Developments in New York State, 1963. Am. Assoc. Petrol. Geol. Bull., v. 48, No. 6, June 1964, pp. 778–783

Frontier Oil Refining Corp., Division of Ashland Oil & Refining Co., Tonawanda, operated a skimming, cracking, and asphalt plant having daily crude capacity of 30,000 barrels, cracking capacity of 12,000 barrels, and reforming capacity of 8,000 barrels. Mobil Oil Co. operated a skimming and cracking plant in Brooklyn with a crude oil capacity of 27,300 barrels per day and a cracking capacity of 20,800 barrels per day. Mobil also operated a skimming, cracking, and asphalt plant at Buffalo with a daily crude capacity of 33,400 barrels, cracking capacity of 21,600 barrels, and reforming capacity of 8,900 barrels.

TABLE 12.—Petroleum production

(Thousand 42-gallon barrels and thousand dollars)

Year	Quantity	Value	Average value per barrel	Year	Quantity	Value	Average value per barrel
1954–58 (average)	2,670	$10,732	$4.02	1961	1,658	$7,892	$4.76
1959	1,970	8,353	4.24	1962	1,589	7,309	4.60
1960	1,813	8,412	4.64	1963 [1]	1,929	8,854	4.59

[1] Preliminary figures.

TABLE 13.—Well completions and drilling footage for field wells and wildcats in 1963

Type of well	Field wells [1]		Wildcats [2]		Total	
	Well completions	Drilling footage	Well completions	Drilling footage	Well completions	Drilling footage
Crude	245	286,030	----	----	245	286,030
Gas	12	26,153	15	35,681	27	61,834
Dry	11	24,324	42	140,375	53	164,699
Service	142	146,966	----	----	142	146,966
Total	410	483,473	57	176,056	467	659,529

[1] Oil and Gas Journal v. 62, No. 4, Jan. 27, 1964.
[2] Oil and Gas Journal v. 62, No. 16, Apr. 20, 1964.

REVIEW BY COUNTIES

Albany.—Cement replaced stone as the most valuable mineral commodity produced during 1963 as Albany County led the State in the production of portland cement. The only cement plant was operated by the Atlantic Cement Co., Inc., at Ravena. Portland cement accounted for 84 percent of the total value of all minerals produced in the county. Shipments were principally to consumers in New York and New Jersey, but Atlantic cement was distributed to most States of the eastern seaboard.

The Callanan Road Improvement Co. quarried limestone at South Bethlehem principally for use as concrete aggregate, roadstone, railroad ballast, and blast-furnace flux. Lesser amounts were used for riprap and agstone. Bluestone dressed for architectural purposes and flagging was produced at East Berne by Heldeberg Bluestone & Marble, Inc.

TABLE 14.—Value of mineral production in New York, by counties [1 2]

County	1962	1963	Minerals produced in 1963 in order of value
Albany	$2,435,944	$17,620,103	Cement, stone, clays, sand and gravel.
Allegany	387,227	396,415	Sand and gravel.
Broome	1,082,417	1,066,038	Sand and gravel, stone, clays.
Cattaraugus	1,055,844	1,146,193	Sand and gravel, peat.
Cayuga	(3)	686,123	Stone, sand and gravel.
Chautauqua	154,849	120,192	Sand and gravel.
Chemung	(3)	(3)	Do.
Chenango	(3)	257,594	Do.
Clinton	2,745,588	(3)	Iron ore, stone, sand and gravel, lime.
Columbia	(3)	(3)	Cement, stone, sand and gravel, clays.
Cortland	110,970	(3)	Sand and gravel.
Delaware	1,208,146	1,115,355	Stone, sand and gravel.
Dutchess	(3)	(3)	Stone, sand and gravel, clays.
Erie	15,970,902	14,160,511	Cement, stone, sand and gravel, gypsum, clays.
Essex	(3)	(3)	Iron ore, ilmenite, wollastonite, sand and gravel garnet.
Franklin	131,926	182,566	Stone, sand and gravel.
Fulton	113,090	246,440	Sand and gravel.
Genesee	2,699,088	2,808,785	Gypsum, stone, sand and gravel.
Greene	18,382,762	14,883,426	Cement, stone, sand and gravel, clays.
Ha ilton	(3)	4,500	Sand and gravel.
Herkimer	(3)	(3)	Stone, sand and gravel, gem stones.
Jefferson	1,085,923	930,561	Stone, sand and gravel.
Lewis	(3)	(3)	Do.
Livingston	(3)	(3)	Salt, sand and gravel, stone.
Madison	490,124	508,084	Stone, sand and gravel.
Monroe	3,609,017	3,459,412	Stone, sand and gravel, gypsum.
Montgomery	485,419	505,472	Stone, sand and gravel.
Nassau	8,142,261	5,889,509	Sand and gravel, clays.
Niagara	3,941,578	3,865,161	Lime, stone, sand and gravel.
Oneida	2,732,067	2,174,771	Stone, sand and gravel, iron ore.
Onondaga	18,418,280	17,354,455	Lime, salt, stone, cement, sand and gravel, clays.
Ontario	1,410,458	1,476,031	Sand and gravel, stone.
Orange	1,037,964	1,470,919	Sand and gravel, clays, peat, stone.
Orleans	105,579	157,770	Sand and gravel.
Oswego	377,940	(3)	Do.
Otsego	166,475	193,543	Stone, sand and gravel.
Putnam	(3)	(3)	Sand and gravel.
Rensselaer	903,464	1,233,033	Sand and gravel, stone.
Richmond	24		
Rockland	7,144,528	(3)	Stone, sand and gravel.
St. Lawrence	31,872,825	34,252,560	Iron ore, zinc, talc, stone, lead, sand and gravel, silver.
Saratoga	1,161,646	1,089,826	Stone, sand and gravel.
Schenectady	256,272	204,170	Sand and gravel.
Schoharie	(3)	(3)	Cement, stone, clays, sand and gravel.
Schuyler	(3)	(3)	Salt, sand and gravel.
Seneca	(3)	257,935	Stone, peat.
Steuben	527,549	601,154	Sand and gravel.
Suffolk	[4] 6,390,811	6,242,046	Do.
Sullivan	(3)	(3)	Stone, sand and gravel.
Tioga	296,421	404,610	Sand and gravel.
Tompkins	(3)	(3)	Salt, stone, sand and gravel.
Ulster	12,598,042	13,174,489	Cement, stone, clays, sand and gravel.
Warren	(3)	(3)	Cement, garnet, stone, sand and gravel, gem stones.
Washington	632,954	789,991	Stone, sand and gravel.
Wayne	(3)	395,993	Do.
Westchester	779,858	806,064	Stone, sand and gravel, emery, peat.
Wyoming	(3)	(3)	Salt, stone.
Undistributed [5]	[4] 89,925,768	108,089,720	
Total	[4] 240,972,000	[6] 260,221,000	

[1] Bronx, Kings, New York, Queens, and Yates Counties are not listed because no production was reported.
[2] Fuels, including natural gas and petroleum, not listed by counties; value included with "Undistributed."
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Revised figure.
[5] Includes natural gas and petroleum, some gem stones and sand and gravel that cannot be assigned to specific counties, and values indicated by footnote 3.
[6] Data does not add because of rounding.

Powell & Minnock Brick Works, Inc., mined miscellaneous clay for the manufacture of building brick. In October, Powell & Minnock awarded a contract for installation of a new stiff-mud-extrusion face brick plant at Coeymans. The new facility with a daily capacity of 60,000 brick was expected to be in operation by July 1964. Northern Lightweight Aggregate, Inc., mined shale near Cohoes for use in manufacturing lightweight aggregate. At Albany, Industrial Mineral Products, Inc., mined and dried slip clay for pottery and stoneware, refractories and abrasive bonding material. Whitehead Brothers Co. produced molding sand from a pit at Slingerlands. J. H. Maloy, Inc., produced gravel for paving purposes. Albany Gravel Co., Inc., produced sand for construction and gravel for paving from its Cedar Hill Plant at Bethlehem.

Allegany.—Alfred Atlas Gravel & Sand Corp. produced sand and gravel for construction purposes and ice control from pits at Alfred. Sand and gravel for paving and construction was produced at Alfred Station by The Buffalo Slag Co., Inc.; at Friendship, Thomas Moogan produced sand and gravel for paving, construction, and ice control. The Nick Codispoti sand pit was reportedly depleted.

Bronx.—National Gypsum Co., calcined crude gypsum and expanded perlite at its Bronx plant. The calcined gypsum and expanded perlite were used in manufacturing building products at the Bronx and other National Gypsum Co. plants.

Broome.—There were six producers of sand and gravel during the year. Weber's Sand & Gravel and Binghamton Sand & Crushed Stone Corp., produced sand and gravel for paving and construction purposes from pits near Binghamton. Bob Murphy, Inc., Winne & Son, Inc., and Barney & Dickenson, Inc., produced sand and gravel near Vestal.

Crushed sandstone (bluestone) for use as concrete aggregate, roadstone, and riprap was mined at Binghamton by Corbisello Quarries. Quarried bluestone was shipped to Deposit and Hancock for processing as flagging, curbing, and other dressed stone. Binghamton Brick Co., Inc., mined miscellaneous clay near Binghamton for use in the manufacture of building brick.

Cattaraugus.—The Buffalo Slag Co., Inc., E. F. Lippert & Co., and William J. Lippert & Son produced sand and gravel near Allegany for paving and construction purposes. Allegany Sand & Gravel Corp., at Olean and the Buffalo Slag Co., Inc., at its Franklinville plant, also produced construction and paving sand and gravel. Upper Allegheny Sand & Gravel Co., Inc., Onoville, and Work & Silvis Co., Inc., Red House, produced sand and gravel for paving, construction, and ice control. Ray Vogtli & Sons, Inc., produced sand for filtration and sand and gravel for construction purposes. Other operators also contributed to the total production of 1,017,000 tons of sand and gravel. Humus peat was recovered from bogs near Hinsdale. Sales were in both bulk and packages.

Cayuga.—At Auburn, General Crushed Stone Co. processed crushed stone for use in the manufacture of bituminous concrete. Near Auburn, Jay W. Robinson & Son and J. J. Harrington produced sand and gravel for building and paving purposes. Jay W. Robinson & Son installed a 40-ton-per-hour heavy medium process to improve the finished product. John W. Dougherty, Inc., produced sand and gravel

near Skaneateles for construction, paving, and fill. Zonolite Co. produced exfoliated vermiculite from crude material acquired from sources in Montana and South Carolina.

Chautauqua.—Three operators reported production of sand and gravel. Most of the material was recovered from pits near Bemus Point and Jamestown.

Chemung.—Sand and gravel for paving and building construction was produced at Horseheads by Elmira Transit Mix, Inc., and at Big Flats by E. R. Wolcott, Inc. Dalrymple Gravel & Construction Co., near Elmira, produced sand and gravel for building and paving. Frank Treat produced sand at Breesport.

Chenango.—B & B Builders Supplies, Inc., produced sand and gravel near Greene for construction purposes. At Sherburne, the Bundy Concrete Co. produced sand and gravel for building construction and gravel for paving. Total output of sand and gravel was 171,672 short tons.

Clinton.—Republic Steel Corp. mined magnetite iron ore at its underground Chateaugay mine near Lyon Mountain. Mill concentrates were sintered at the company agglomeration plant prior to shipment for use in the manufacture of pig iron and steel.

International Lime & Stone Corp., Chazy, produced quicklime and hydrated lime for use in manufacturing paper. In addition, limestone was quarried for lime, roadstone, and agricultural uses. Plattsburgh Quarries, Inc., Plattsburgh, quarried limestone for concrete aggregate and roadstone. As a byproduct of iron ore mining, Republic Steel Corp. marketed gneiss for concrete aggregate and stone sand. Some sand was produced for paving and ice control.

Columbia.—Cement production was lower than that of 1962, but continued to be the most valuable commodity followed by stone and sand and gravel. Ninety-four percent of the cement produced was portland, and the remainder was masonry cement. Plants were operated by Universal Atlas Cement Division, U.S. Steel Corp., Hudson, and Lone Star Cement Corp., Greenport. Cement was shipped to New ground Chateaugay mine near Lyon Mountain. Mill concentrates limestone from a quarry at Greenport, and Catskill Mountain Stone Corp. operated a quarry at Hudson. The stone was used as concrete aggregate, roadstone, and agstone. Sand for building, paving, and ice control was produced by F. H. Stickles & Son from a pit at Livingston. Cairo Redi-Mix produced sand and gravel near Craryville for use in paving, construction, and fill. Shale for use in cement production was mined near Greenport by Universal Atlas Cement.

Cortland.—Cortland Ready Mix, Inc., and Aggregate Materials Corp. produced sand and gravel from pits near Cortland for use in building, paving, fill, and other purposes.

Delaware.—Bluestone quarries accounted for most of the mineral production in the county. Bluestone was processed for flagging, architectural work, rough and dressed building stone, and rubble, by Willis Hankins and Paul Tompkins Estate, Hancock; American Bluestone, Masonville; W. R. Strong & Son, Deposit; and Johnston & Rhodes Bluestone Co., East Branch. Cooney Bros, Inc., Hancock, produced crushed sandstone for use as concrete aggregate and roadstone.

Dutchess.—Limestone was the principal mineral commodity produced in the county. New York Trap Rock Corp., New Hamburg, and Dutchess Quarry & Supply Co., Inc., Pleasant Valley, produced limestone for concrete aggregate, roadstone, and riprap. The White Marble Corp. quarry near Wingdale acquired by New York Limestone Corp., was idle during the year. Fourteen sand and gravel operations were active in the county, four less than in 1962. Production totaled 438,000 tons, 26 percent less than that of 1962. The sand and gravel was used for building, construction, paving, and fill. Miscellaneous clay and shale were produced near Beacon by Beacon Brick Corp. for the manufacture of building brick.

Erie.—Penn-Dixie Cement Corp. and Lehigh Portland Cement Co. produced portland and masonry cement at Buffalo. Most of the output was sold to ready-mixed concrete companies, the remainder was shipped to contractors, building material dealers, and manufacturers of concrete products. Production of cement was less than that of 1962. Kelly Island New York Corp., Buffalo, closed its lime plant. Four companies quarried and crushed limestone for use in concrete aggregate, roadstone, riprap, and railroad ballast. Output was 2 percent less than in 1962.

There were 14 operations producing sand and gravel for building, paving, and fill, although production was 4 percent less than that of 1962. Pine Hill Concrete Mix Corp. also produced filtration sand at Lancaster. Major producers of sand and gravel for construction were Dan Gernatt Gravel Products, Inc., Collins; Jamison Bank Run Gravel Corp., East Aurora; and Clarence Sand & Gravel Corp., Clarence.

National Gypsum Co. and Bestwall Gypsum Co., produced calcined gypsum from crude ore extracted from mines near Clarence Center. Universal Atlas Cement Division, U.S. Steel Corp., mined gypsum at Clarence Center for use as a retarder in portland cement. Hamburg Shale Co., Inc., mined shale for the manufacture of cement at Hamburg. Also at Hamburg, Boston Valley Pottery Co., produced clay for use in making flower pots. Acme Shale Brick Co., Inc., at Lake View and Buffalo Brick Corp. at West Falls recovered miscellaneous clay and shale for the manufacture of building brick. Penn-Dixie Cement Corp. produced clay and shale near Buffalo for use in making cement. Haydite Division, Anchor Concrete Products, Inc., mined shale for lightweight aggregate at a plant near Jewettville.

The Carborundum Metals Co. produced magnesium chloride as a byproduct of zirconium production at its Akron plant. Magnesium chloride was used in the preparation of magnesium flux. Perlite was expanded by Bestwall Ggypsum Co. at Akron and by National Gypsum Co. at Clarence Center. The crude perlite was shipped from Colorado mines. Buffalo Perlite Corp. purchased crude perlite in Nevada, Oklahoma, and Colorado. The expanded perlite was used as ultra-lightweight concrete aggregate, for plaster, loose fill insulation, soil conditioning and filtration.

Essex.—Republic Steel Corp. produced magnetite from its underground Old Bed—Harmony mine near Mineville. Ore from the mine was beneficiated at the Company's No. 7 concentrator and sintered before shipment. National Lead Co., Titanium Division, recovered

magnetite from titaniferous magnetite ore at its MacIntyre open-cut mine at Tahawus. The ore was processed by heavy-medium separation, flotation, magnetic separation, and sintering. Magnetite shipped was used for pig iron, steel, cement, and as a heavy medium for mineral separation. Ilmenite, recovered as a coproduct was used mostly in pigments.

Cabot Minerals Division, Cabot Corp. mined wollastonite underground near Willsboro. Wollastonite was finely ground for use in the manufacture of ceramics, paint, plastics, and certain building products. Byproduct garnet (andradite) was sold as an abrasive. Adirondack Development Corp. mined wollastonite at its Deerhead mine near Lewis and processed the ore in a plant erected in cooperation with Area Redevelopment Administration. The output was used for experimental purposes.

Saranac Lake Sand & Gravel Co., Inc., and Clarence G. Brooks produced sand and gravel at Saranac Lake for paving and building construction. Thompson Excavating Corp. at Ticonderoga and Oril H. Gordon at Keeseville also produced sand and gravel for construction and paving purposes. International Paper Co. regenerated lime for use in the manufacture of paper.

Franklin.—Sandstone continued as the leading commodity. Adirondack Stone Quarries, Inc., produced dimension sandstone, flagging, and irregular facing stone for construction from a quarry at Burke. Manufacturing Concrete Products produced sand and gravel for building construction and fill from pits at Malone. Louis Paro and Herman LaBounty also recovered sand and gravel at Malone and St Regis Falls, respectively.

Fulton.—Nine commercial operators produced 261,000 tons of sand and gravel, a substantial increase over production in 1962. Uses included building, paving, fill, and ice control. Principal producers were John D. Moynehan and Santos Construction Corp., Gloversville; Paul Bradt, Northville; and Twin Cities Sand Co., Johnstown.

Genesee.—Crude gypsum mined underground was calcined by U.S. Gypsum Co. at its Oakfield plant. Production of crushed limestone decreased compared with that of 1962. Limestone quarries at LeRoy were operated by General Crushed Stone Co. and LeRoy Lime & Crushed Stone Corp. Genesee Stone Products Corp. mined limestone at its Stafford quarry. Crushed limestone produced in the county was used principally for concrete aggregate and roadstone (89 percent), railroad ballast (9.7 percent), and agricultural lime (1 percent); a small quantity was used for riprap. Batavia Washed Sand & Gravel Co., Inc., and Western N.Y. Concrete Corp. produced sand and gravel from pits near Batavia for use in building construction and fill. Frey Sand & Gravel Corp., Alexander, also produced sand and gravel.

Greene.—Greene County, with 20 percent of the State total, ranked second in value of cement shipments. Portland and masonry cement were manufactured by Lehigh Portland Cement Co. and Marquette Cement Manufacturing Co. near Alsen and by Alpha Portland Cement Co. at Catskill. Limestone mined at nearby quarries was the principal raw material. Marquette Cement Manufacturing Co. also mined clay for its own use. Purchased cement ingredients included gypsum,

iron ore, and mill scale. Most of the finished cement was shipped to consumers in New York, New Jersey, and New England States. Limestone was produced at Alsen, Windham, and Catskill for cement, riprap and asphalt filler. At Coxsackie, Whitehead Brothers Co. recovered molding sand and Coxsackie Sand & Gravel Co., Inc., produced sand for building and gravel for paving.

Hamilton.—One operator reported production of gravel for paving.

Herkimer.—Limestone for concrete aggregate and roadstone was produced by Eastern Rock Products, Inc., at Middleville and General Crushed Stone Co. at Jordanville. Eastern Rock Products, Inc., completed installation of a 15 stage, 350-ton-per-hour crushing plant. Material Sand & Gravel Co., Inc., Gravesville, and Nash Sand Co., Poland, produced sand and gravel for building, paving, and ice control. Quartz crystals (Herkimer diamonds) were collected near Middleville.

Jefferson.—Limestone for concrete aggregate, roadstone, railroad ballast, and agstone was quarried and crushed at Watertown by General Crushed Stone Co. The highway department of the Town of Cape Vincent produced crushed limestone for concrete aggregate and roadstone. Multi-Color Sandstone Co. quarried and processed dimension stone for architectural use. Eighteen operators reported production of 448,000 tons of sand and gravel. Principal pits were at Watertown, Antwerp, Adams, Alexandria Bay, and Belleville.

Lewis.—The Carbola Chemical Co., Inc., operated a limestone quarry at Dianna, producing crushed and ground limestone for use as whiting, as a filler in soap and insecticides, and for chemical uses. Sand and gravel for paving was produced from pits near Lowville.

Livingston.—Production of salt was 14 percent greater than in 1962, and Livingston County ranked first in the State. International Salt Co., Inc., produced rock salt from its Retsof mine. Most of the output was consumed in the New England and Middle Atlantic States, for chemical purposes, ice removal, and a wide variety of other uses. Six producers of sand and gravel reported production of 589,000 tons of material for building, paving, fill, and ice control. Principal operators were The Valley Sand & Gravel Corp. at Wadsworth and Canawaugus, Cole Sand & Gravel Corp., Avon, and Chester L. McMaster, Dansville. Crushed limestone mined at Honeoye Falls, was used for concrete aggregate and roadstone.

Madison.—Output of limestone, the principal mineral product in the county, totaled 250,000 short tons. The crushed stone was used mainly for concrete aggregate and roadstone; 12 percent was used for riprap and agricultural purposes. Quarries were at Clockville, Perryville, and Munnsville. Munnsville Limestone Corp. added equipment to increase loading capacity at stockpiles. Cossitt Concrete Products, Inc., with pits at Earlville, produced sand and gravel for building, paving, and fill.

Monroe.—Crushed limestone accounted for the major part of the value of the county's mineral production, although the total value of output was 16 percent less than in 1962. Dolomite Products Co. quarried and crushed limestone at Penfield and Gates for use in concrete aggregate, roadstone, railroad ballast, agstone, and riprap. Concrete Materials, Inc., operated a limestone quarry at Sweden to pro-

duced concrete aggregate and roadstone. Production of sand and gravel was greater than in 1962. Output for building, paving, and fill was obtained principally from pits at Rochester, Pittsford, Penfield, Spencerport, and Scottsville. The Ruberoid Co. produced crude gypsum at Wheatland for shipment to Caledonia (Livingston County) where it was converted to finished building products.

Montgomery.—Crushed limestone was produced at Amsterdam by Cushing Stone Co., Inc., and Crushed Rock Products, Inc. The material was delivered by truck for use in concrete aggregate and for roadstone. Three operators reported production of sand and gravel for building, paving, and fill from pits near St. Johnsville and Fonda.

Nassau.—Production of sand and gravel was lower than in 1962, but Nassau County continued to lead in the production of this commodity, producing 5.4 million tons valued at $5.7 million. Certified Sand & Gravel Corp. operated dredging plants at Hicksville, Bellmore, and Oyster Bay. Other producers were Colonial Sand & Stone Co., Hempstead and Port Washington, Pine Hollow Sand & Gravel Co., Inc., Oyster Bay, and Penn Industries, Inc., Roslyn. The entire production of sand and gravel was used for building construction, fill, and paving. Nassau Brick Co., Inc., produced clay for the manufacture of brick near Farmingdale.

Niagara.—At North Tonawanda, International Paper Co. produced quicklime and recycled hydrated lime for use in paper manufacture. Quicklime was made for use in production of calcium carbide and cyanide by Union Carbide Olefins Co., Niagara Falls. Hydrated lime was sold for metallurgical use and sewage treatment. Frontier Stone Products, Inc., produced crushed limestone at Lockport for use in concrete aggregate, roadstone, riprap, and agstone. Niagara Stone Division of McLain Industries, Inc., quarried and crushed limestone at Niagara Falls for concrete aggregate, roadstone, and railroad ballast. At Gasport, Royalton Stone Corp. produced crushed limestone for concrete aggregate, roadstone, metallurgy, and agstone. Gasport Sand & Gravel Co., Inc., closed its pit at Lockport. A small quantity of sand and gravel was produced for paving by various producers. Artificial graphite made from petroleum coke at the Niagara Falls plant of Union Carbide Corp., Carbon Products Division, was used in various applications.

Oneida.—Crushed limestone was produced at Oriskany Falls by Eastern Rock Products, Inc., mainly for concrete aggregate and roadstone; the remainder was used as riprap and agricultural limestone. Production totaled 730,000 tons and the value of commercially produced sand and gravel increased 9 percent. Principal producers were Eastern Rock Products, Inc., Gravesville and Boonville; Watson Brothers Gravel Bed, Inc., Verona; Hanicker Bros., Rome; Humphrey D. Jones and Ludlow Sand & Gravel Co., Inc., both near Clayville. George W. Bryant Core Sands, Inc., and Whitehead Bros. Co. produced molding sand at McConnellsville. Clinton Metallic Paint Co. mined red iron oxide pigment (hematite) at its Brimfield underground mine. The ore was ground for use as pigment in paint and concrete. Zonolite Co. produced exfoliated vermiculite at Utica. Crude vermiculite was received from Montana, South Carolina, and South Africa.

Onondaga.—Solvay Process Division, Allied Chemical Corp., quar-

ried limestone at Jamesville. Quicklime for chemical uses was made from part of the limestone; the remainder of the stone was sold for concrete aggregate and roadstone. Brine from salt wells operated by Solvay was used with the quicklime to make soda ash at Syracuse. Some of the brine was vaporized in pans and sold as evaporated salt.

General Crushed Stone Co., at its Jamesville quarry, mined and crushed limestone for use in ready-mixed concrete and as roadstone. Dimension limestone was produced at Manlius by Brickyard Falls Farm. Alpha Portland Cement Co. produced portland and masonry cement at its Jamesville plant. Most of the portland cement output was used in ready-mixed cement. Alpha mined shale at its nearby quarry and purchased limestone, sand, gypsum, and iron ore as cement raw materials. Shipments were principally by truck to consumers in New York and Pennsylvania.

Eleven sand and gravel operations produced 1.1 million tons, 337,000 tons less than in 1962. Principal production centers were Nedrow, Fayetteville, and Syracuse. Shipments were by truck. The sand and gravel was used principally for building, paving, and fill. Lightweight aggregate was produced by Onondaga Lightweight Aggregate Corp. at Warners by sintering shale mined at a nearby pit. Syracuse Pottery Co., Inc., mined miscellaneous clay for manufacturing art pottery and flower pots at Camillus. Expanded perlite, produced at Syracuse by Minerals Processing Corp. from perlite mined out-of-State, was used for soil conditioning, acoustical plaster, and ultralightweight concrete.

Ontario.—Ten producers of sand and gravel reported production of 680,000 tons, an increase of 131,000 tons over that of 1962. The material was used mainly for building construction, paving, and fill, with a minor amount used for abrasives and ice control. Transportation by truck was made from pits located at Clifton Springs, Phelps, Geneva, Oaks Corners, and Victor. Crushed limestone for concrete aggregate, roadstone, and railroad ballast was produced at Geneva by General Crushed Stone Co.

Orange.—Sand and gravel continued as the leading mineral commodity in the county and exceeded the tonnage recorded in 1962 by 2 percent. Principal uses were for building and paving with a minor amount used for ice control. Leading producers were The Windsor Building Supplies Co., Inc., Newburgh; A. W. Hollenbeck, Inc., Chester; Delaware Valley Sand & Gravel Co., Inc., Port Jervis; and Dickinson Sand & Gravel Co., Bloomingburg. The Jova Brick Works at Roseton produced miscellaneous clay and shale for the manufacture of building brick. Humus peat was recovered from bogs near Middletown and sold in bulk by Mt. Bethel Humus Co. Sterling Forest Peat Co., Inc., produced reed-sedge peat near Tuxedo for sale in both package and bulk. Duchess Quarry & Supply Co., Inc., quarried and crushed limestone at Goshen for aggregate use. Deliveries were by truck.

Orleans.—Production of sand and gravel for building construction, paving, and fill was from pits operated by B. R. DeWitt, Inc., at Shelby, Barre, and Ridgeway; Oak Orchard Sand & Gravel Co. and Burton Mundion, Medina; and Arnold H. Picketts Sand & Gravel Pit, Albion.

Oswego.—Sand and gravel was produced mainly for building construction, paving, and fill by Zupan Stone, Sand & Gravel, Inc., Hastings; General Crushed Stone Co., Lacona; Sea Way Sand & Gravel, Inc., and Davies Sand & Gravel, Inc., Oswego. Whitehead Bros. Co. produced molding sand from a pit near Pulaski.

Otsego.—Barrett Division of Allied Chemical Corp., Springfield Center, produced crushed limestone for use as concrete aggregate and riprap. Oneonta Blue Stone Co., Inc., produced dimension sandstone for construction work and cut stone for architectural purposes at Oneonta. Seward Gravel Co., Milford, and Unadilla Concrete Products Co., Unadilla, produced sand and gravel for building, paving, and fill. Transportation to site of use was by truck.

Putnam.—Harlem Valley Crusher Co., Inc., Patterson, and Leemac Sand & Stone Corp., Cold Spring, produced sand and gravel for building, paving, and fill.

Rensselaer.—Production of sand and gravel totaling 737,000 tons was reported from 21 operations. Albany Gravel Co., Inc., was the largest producer. Most of the output was used for building, paving, and fill; other uses included ice control, filtration, and golf courses. Fitzgerald Bros. Construction Co., Inc., produced crushed graywacke at the Campbell Mountain Quarry, Brunswick. The material was used as concrete aggregate and roadstone.

Richmond.—U.S. Gypsum Co. calcined crude gypsum at its New Brighton plant for use in making finished building products.

Rockland.—Rockland County continued to rank second in the State among stone-producing counties. New York Trap Rock Corp. quarried and crushed limestone at Tomkins Cove and basalt at Haverstraw and West Nyack. Suffern Stone Co., Inc., also mined basalt at its Suffern quarry. The crushed stone was used principally as concrete aggregate and roadstone. Four operators produced sand and gravel for use in building, paving, and fill. Leading producers were Graney Building Material Corp., Sparkill; Mt. Ivy Sand & Gravel Co., Inc., Congers; and Ward Pavements, Inc., Thiells. Ramapo Sand & Gravel Corp., Hillburn, closed down. U.S. Gypsum Co. produced calcined gypsum at its plant at Stoney Point.

St. Lawrence.—Jones & Laughlin Steel Corp., the largest producer of iron ore in the State, mined magnetite by open pit at the Benson mine near Star Lake. Crude ore was beneficiated at the nearby mill. Most of the concentrates were agglomerated by sintering before shipment. Concentrates and sinter were used in making pig iron and steel. St. Joseph Lead Co. produced zinc from the Edwards mine and lead, zinc, and silver from the Balmat mine, both near Gouverneur. Production of lead and zinc was slightly less than in 1962. Output of silver increased. Zinc concentrates were shipped to the company smelter at Josephtown, Pa., for the recovery of zinc. Lead concentrates from the Balmat mine and lead residue from the Josephtown smelter were shipped to the smelter at Herculaneum, Mo., for the recovery of lead and silver. Sulfide ores were recovered from both mines, using the room and pillar method.

Gouverneur Talc Co., Inc., recovered talc from the Balmat mine. International Talc Co., Inc., operated the Arnold pit and Wight and No. 3 talc mines near Balmat and Edwards. Both companies oper-

ated grinding mills and produced ground talc for use in ceramics, paint, rubber, and floor and wall covering. Limestone quarries were operated at Norfolk and Ogdensburg by Barrett Division of Allied Chemical Corp. and McConville, Inc., respectively. The limestone was crushed for use in concrete aggregate, roadstone, agricultural limestone, and riprap. Crushed marble for roadstone and agricultural purposes was produced at Gouverneur by Balducci Crushed Stone Co. Commercial production of sand and gravel was reported by eight operators; three pits were idle. Leading producers were Putnam-Hawley Building Materials, Inc., Potsdam; George Cooke, Sprague ville; Wylie Stout, Brier Hill; and Benjamin E. La Rue, Norfolk. The material was used for building, paving, and fill and was transported by truck.

Saratoga.—Glens Falls Portland Cement Co., Division of The Flintkote Co., produced limestone for its cement plant at Glens Falls (Warren County). Limestone was quarried and crushed by the Pallette Stone Corp. at Saratoga Springs for use as concrete aggregate, roadstone, agstone, and riprap. Commercial sand and gravel production totaling 229,000 tons was used for building, paving, fill, and as industrial sand. The leading producer was Pallette Stone Corp., Corinth. Engine and molding sand was produced by Whitehead Bros. Co., Gansevoort; William Fawthrop, Milton and Clifton Park; W. J. Dyer Molding Sand Co., Jonesville; and Archie Meyers, Jewett Sand Co., and Hynes Bros., all at Ushers.

Schenectady.—Six operators at seven pits produced 133,000 tons of commercial sand and gravel for building, paving, and fill—a decrease of 37,000 tons from that of 1962. Material was recovered from pits near Glenville, Schenectady, and Rotterdam.

Schoharie.—Marquette Cement Manufacturing Co. produced portland and masonry cement at its Howes Cave plant. The company used limestone and shale mined nearby as the principal cement raw material. Sand, gypsum, and iron ore were purchased. Shipments were principally to consumers in New York and New England. Crushed limestone was produced by Masick Soil Conservation Co., Schoharie Stone Corp., and Cobleskill Stone Products Division of Allied Materials Corp. The latter company installed additional crushing facilities during the year. Sand and gravel for use in building, paving, and fill was produced by Jefferson Sand & Gravel at Jefferson.

Schuyler.—Evaporated salt was produced by International Salt Co., Inc., and Watkins Salt Co., Inc., both near Watkins Glen. The salt was used chiefly by the chemical textile and dyeing and food industries. New York, Pennsylvania, and New Jersey were the principal marketing areas for the evaporated salt; small quantities were exported. Sand and gravel was recovered from a pit near Watkins Glen by D. & T. Franzese Bros., Inc.

Seneca.—Warren Brothers Road Co. produced crushed limestone for use as concrete aggregate, roadstone, and riprap. Finger Lakes Peat Moss Co. produced reed-sedge peat from bogs near Junius. All the peat produced was sold in bulk.

Steuben.—Value of commercial sand and gravel produced for building, paving, and fill was greater than in 1962. Producers were Rhine-

hart Sand & Gravel, Inc., Corning; Dalrymple Gravel and Contracting Co., East Corning; Bath Sand & Gravel Co., Inc., Bath; and The Buffalo Slag Co., Inc., Cohocton.

Suffolk.—Suffolk rose from second to first place among sand- and gravel-producing counties with 7.1 million tons recovered at 23 operations. Output of more than 500,000 tons was reported by five producers. Most (92 percent) of the sand and gravel was processed before shipment; 48 percent was shipped by water, 52 percent by truck.

Sullivan.—Sullivan Highway Products Corp. operated quarries at Monticello and Kenoza Lake, producing sandstone for concrete aggregate and roadstone. Sullivan Highway Products Corp., Monticello; L. Finkle & Son, Inc., Summitville; and Valley Sand & Gravel Co., Mongaup Valley, produced sand and gravel for building, paving, fill, and ice control.

Tioga.—Combined production of 292,000 tons of sand and gravel was reported by Concrete Materials, Inc., and C. & C. Ready-Mix Corp., Owego; Herman E. Bunce Sand & Gravel, Barton; and A. O. Swanson, Waverly. The sand and gravel was used for building, paving, fill, ice control, and other purposes.

Tompkins.—Cayuga Rock Salt Co., Inc., produced rock salt from an underground mine at Myers for use in food processing, chemicals, and highway deicing. Principal shipments were to New York, New Jersey, Pennsylvania, and New England States. Crushed limestone was quarried at South Lansing by Cayuga Crushed Stone, Inc., for use in concrete aggregate and roadstone, riprap, and agricultural and metallurgical purposes. A roll crusher was added during the year to allow better control of product sizes. At its University Quarry, Dryden, Finger Lakes Stone Co., Inc., produced irregular shaped sandstone for construction work and sawed stone for architectural purposes. University Sand & Gravel Co. and Rumsey-Ithaca Corp., both at Ithaca, produced sand and gravel for fill and building purposes.

Ulster.—Ulster County ranked fourth in value of cement production. Natural and masonry cement was produced from natural cement rock mined underground at Rosendale by Century Cement Mfg. Co., Inc. Hudson Cement Division, Colonial Sand & Stone Co., Inc., produced portland cement at its Kingston plant. In addition to limestone (cement rock) quarried nearby, gypsum, mill scale, and pyrite sinter were used as cement raw materials. The Callanan Road Improvement Co., mined limestone at Esopus for concrete aggregate and roadstone.

At Kingston, Hudson Lightweight Stone Division, Colonial Sand & Stone Co., Inc., and Nytralite Aggregate, Inc., Division of New York Trap Rock Corp., mined miscellaneous shale for use in making lightweight aggregate. Also at Kingston, The Hutton Co., and Star Brick Co., mined clay for the manufacture of building brick. Hudson Valley Lightweight Aggregate Corp. produced expanded shale aggregate in rotary kilns at a plant near Saugerties. Hurley Sand & Gravel Co., Inc., produced building and paving sand at High Falls. Inter-County Block Corp., at Marlboro produced sand and gravel for building and concerte block manufacture. Orange & Ulster County Shale Co., Inc., produced paving gravel at Milton.

Warren.—Masonry and portland cement were manufactured at the Glens Falls plant of the Glens Falls Portland Cement Co., Division

of The Flintkote Co. Limestone (cement rock) quarried in Saratoga County was the principal cement raw material. Sand, gypsum, and iron ore also were used. The Jointa Lime Co. quarried limestone at Glens Falls for use as concrete aggregate and roadstone. Raymond E. Bates and Isabelle Harris operated sand and gravel pits at Glens Falls. Warren Aggregates, Inc., quarried and crushed granite at Chestertown for use in highway construction and railroad ballast, and also produced a small quantity of paving sand. Barton Mines Corp., produced abrasive garnet near North Creek. Garnet was recovered from open pits and processed for use as a coated abrasive in glass grinding and polishing and for metal lapping. Specimen garnet was collected from a locality near North Creek. Also, some labradorite was collected.

Washington.—The Tri-County Stone Co., Inc., quarried dimension limestone and also produced crushed limestone at its plant at Hudson Falls. Crushed stone was used for concrete aggregate, roadstone, and asphalt filler. At Granville, six operators produced approximately 7,700 tons of slate for flagging, roofing and mill stock purposes. Two similar quarries were in operation at Hampton. Flagging, roofing slate, and sculps for facing buildings were produced at East Whitehall. Two slate quarries at Middle Granville produced flagging, roofing slate, and slate tile. A total of 22,131 tons of slate was produced in the county, of which 197 tons were shipped to Canada. Fred and Ralph Bassett discontinued business, and Fair Haven Slate Co., Inc., remained inactive the entire year. Sand for masonry and ice control was produced from pits near Salem and Greenwich.

Wayne.—At their plant, Dolomite Products Co., produced limestone for concrete and roadstone. General Crushed Stone Co. produced crushed limestone from its quarry at Sodus for use as concrete aggregate, roadstone, and for agricultural purposes. Sand and gravel was used for building, paving, fill, and ice control. Shipments were made by truck from pits near Palmyra, Red Creek, and Galen.

Westchester.—At Yonkers, Baratta & D'Amato, and Di Rienzo Brothers produced rough and dressed granite for construction work and curbing. The Lake Street Granite Quarry, Inc., operating at White Plains, produced dimension granite for architectural application and rubble for rough construction. Cut granite was processed for use as curbing. Universal Marble Products Corp., quarried marble for use as cast stone, stucco, agstone, whiting, and asphalt filler. Sand and gravel was recovered from three pits near Peekskill and Carmel. The entire output was shipped by truck for use in building, paving, and fill. DiRubbo American Emery Ore produced emery for abrasive purposes from the Kingston mine near Croton. DeLuca Emery mine operated two mines near Peekskill, recovering emery for shipment to a plant in Peekskill for use as aggregate in heavy duty, nonslip floors and pavements. Stone Age Humus Corp., produced humus peat from bogs near Armonk.

Wyoming.—At Silver Springs, Morton Salt Co. produced evaporated salt from brine, using vacuum pans. Sales were chiefly for food processing, chemical, and industrial purposes. American Bluestone Co. produced dimension sandstone (bluestone) for construction purposes and dressed stone for architectural work from a quarry at Portageville.

The Mineral Industry of North Carolina

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of North Carolina for collecting information on all minerals except fuels.

By James R. Boyle [1] and Jasper L. Stuckey [2]

PRODUCTION of mineral commodities decreased for the first year since 1957; total value of mineral production was $45 million, compared with $55 million in 1962, a decrease of 18 percent. The principal minerals mined, in decreasing order of value, were stone, sand and gravel, feldspar, clays, lithium minerals, and scrap mica. North Carolina was first in the Nation in producing lithium minerals, feldspar, sheet mica, and scrap mica; second in olivine and crushed granite; and third in talc and pyrophyllite combined.

TABLE 1.—Mineral production in North Carolina [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasive stones (millstones)	(2)	$2	(2)	$2
Clays [3] thousand short tons	2,731	1,782	2,735	1,761
Feldspar thousand long tons	245	2,373	268	2,821
Gem stones	(2)	2	(2)	14
Gold (recoverable content of ores, etc.) troy ounces	460	16	33	1
Iron ore (usable) long tons, gross weight	1,090	13	730	10
Lead (recoverable content of ores, etc.) short tons	219	40	62	13
Mica:				
Scrap thousand short tons	62	1,384	62	1,497
Sheet pounds	320,305	867	92,961	13
Sand and gravel thousand short tons	12,516	11,457	11,028	10,132
Silver (recoverable content of ores, etc.) troy ounces	100,439	109	26,754	34
Stone thousand short tons	19,308	29,533	15,701	25,683
Talc and pyrophyllite do	100	433	107	446
Zinc (recoverable content of ores, etc.) short tons	----	----	13	3
Value of items that cannot be disclosed: Asbestos, cement (portland 1963), copper, kaolin, lithium minerals, olivine, and tungsten	----	6,586	----	2,464
Total	----	54,597	----	44,894

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Excludes kaoline, included with "Value of items that cannot be disclosed."

[1] Mining engineer, Bureau of Mines, Knoxville, Tenn.
[2] State geologist, North Carolina Geological Survey, Raleigh, N.C.

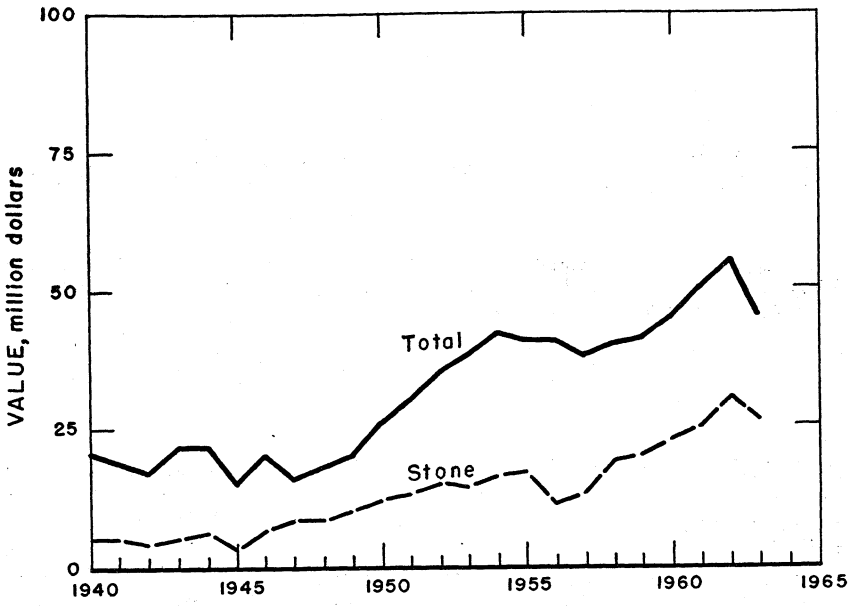


FIGURE 1.—Value of stone, and total value of mineral production in North Carolina, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$44,009	1958	$41,521
1953	42,955	1959	40,365
1954	45,513	1960	44,196
1955	44,703	1961	50,050
1956	41,641	1962	54,122
1957	38,066	1963	44,467

Trends and Developments.—Texas Gulf Sulphur Co. planned to invest $45 million in facilities for mining and processing phosphate rock at Lee Creek phosphate mine near Aurora in Beaufort County. Upon completion of the plant in 1966, initial rate of phosphate rock production will be 3 million tons per year. An experimental floating dredge in an open pit to mine the phosphate rock was placed in operation in mid-1963, and a pilot processing plant was to begin treatment of dredged phosphate rock early in 1964. Magnet Cove Barium Corp. and Pamlico Mining & Chemical Corp. have recently explored phosphate deposits in the same area.

Aluminum Company of America was ready to begin operating its $20 million smelting plant at Badin early in 1964. Plans called for construction of a second potline later in the year. The alumina for the plant is shipped from Mobile, Ala.; the electric energy is from four hydro-electric installations along the Yadkin River.

The Feldspar Corp. completed a tailings disposal system to handle waste materials from its Spruce Pine plant. The plant uses 1.5 million gallons of water a day from a nearby river, and the disposal system removes approximately 200 tons of waste materials per day before returning the water to the river.

Ideal Cement Co. began operation of its new, highly instrumented cement plant at Castle Hayne, constructed at a cost of $20 million; the plant has an annual capacity of 3.5 million barrels.

Beryllium Metals & Chemicals Corp. began operation of its plant at Bessemer City. The plant produces electrorefined beryllium from beryllium scrap.

Carolina Nitrogen Corp. began production at its $10 million nitrogen fertilizer plant at Wilmington. The plant, with an annual capacity of 250,000 tons, uses ammonia from Trinidad.

Water.—Table 3 shows the water use in the mineral industry of the State. Of the total, 32 percent was recirculated. Nonmetal mines and mills was the largest consumer, using 46 percent; followed by sand and gravel operations, 36 percent; quarries and mills, 17 percent; and metal mine and mills, 1 percent.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Industry	New water	Recirculated water	Total water use
Quarries and mills	1,388	646	2,034
Metal mines and mills	50	11	61
Nonmetal mines and mills	2,872	2,480	5,352
Sand and gravel mines	3,588	639	4,227
Total	7,898	3,776	11,674

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Stones.—Millstones were produced in Rowan County from purchased materials.

Asbestos.—Powhatan Mining Co. mined amphibole asbestos near Burnsville in Yancey County. Production decreased 5 percent in tonnage and 4 percent in value.

Cement.—Ideal Cement Co. started operation of a plant at Castle Hayne, New Hanover County, the first cement plant ever to be built in the State.

Clays.—Total clay production increased slightly in tonnage but decreased 2 percent in value. Kaolin decreased 5 percent in tonnage and value, and miscellaneous clay increased slightly in tonnage but decreased 1 percent in value. Harris Clay Co., Avery County, was the

only kaolin producer. Miscellaneous clay was mined by 31 companies from 36 pits in 22 counties, for manufacturing building brick, lightweight aggregate, other heavy clay products, and cement. Principal producers were Sanford Brick Corp., Carolina Solite Corp., Boren Clay Products Co., Sampson Brick Co., Inc., Pine Hall Brick & Pipe Co., and Borden Brick & Tile Co.

Feldspar.—The production of crude feldspar increased 9 percent from that produced in 1962, and the value increased 19 percent. The unit value increased from $9.70 per long ton in 1962 to $10.54. International Minerals & Chemical Corp. (Hawkins mine), The Feldspar Corp. (Poteat, Wiseman, Sullins, Bacchus, and Alexander mines), and Lawson-United Feldspar and Minerals Co. (Minpro mine) alaskite and recovered feldspar concentrates in Mitchell, Swain, and Yancey Counties. Foote Mineral Co. recovered byproduct feldspar at its lithium plant in Cleveland County. Crude lump feldspar from Mitchell and other counties comprised the balance of the production.

Sales of ground feldspar were 297,400 short tons, 16 percent more than in 1962 and 6 percent more than in 1959, previous record year. Value was $3,611,300, an increase of 26 percent over the 1962 figure. The production of ground feldspar for glass uses increased 6 percent in quantity but decreased 2 percent in value. The quantity used for pottery increased 27 percent, with a 21 percent increase in value.

Gem Stones.—Gem stones and gem material worth an estimated $14,000 were collected in 31 counties in 1963. Leading counties were Macon, Mitchell, and Lincoln. Among the minerals reported were sapphire, beryl, ruby, emerald, smoky quartz, corundum, rhodolite garnet, and amethyst.

Lithium.—Foote Mineral Co. mined and milled spodumene at Kings Mountain, Cleveland County.

Mica.—Sheet mica decreased in quantity and value. Scrap mica tonnage was the same as 1962 but increased 8 percent in value. Production of mica was reported from 16 mines in 5 counties, compared with 78 mines in 10 counties in 1962. Some tonnage could not be identified with respect to county or mine of origin. Mitchell County, with seven mines, accounted for 22 percent of the total value of mica production; Avery, Cleveland, Macon, and Yancey accounted for 71 percent; counties of origin could not be identified for the remaining 7 percent. Principal scrap mica producers were Harris Clay Co., Southern Mica Co. of North Carolina, Deneen Mica Co., Kings Mountain Mica Co. Inc., The Feldspar Corp., Western Mica of North Carolina, and International Minerals and Chemical Corp. Output of ground mica was 9 percent higher than in 1962 and the value increased 16 percent; 10 mica grinders were active during 1963.

Olivine.—Production of olivine decreased in tonnage and value. Mines were operated in Jackson County by Harbison-Walker Refractories Co. and Balsam Gap Co., and in Yancey County by Wiseman Mining Co. Inc. and Georgia Talc Co.

Perlite.—Carolina Perlite Co. Inc. expanded perlite at Gold Hill, Rowan County, from crude material shipped from Colorado. Quantity and value decreased slightly from that in 1962.

Sand and Gravel.—The second mineral commodity in the State in both tonnage and value of production was sand and gravel. Commer-

TABLE 4.—Ground mica sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Roofing	27,002	$783,760	$29.03	(1)	(1)	(1)
Paint	5,133	808,826	157.57	10,229	$1,090,416	$106.60
Rubber	(1)	(1)	(1)	3,554	491,191	138.21
Wallpaper	194	28,242	145.58	324	41,418	127.83
Plastics	270	41,437	153.47	322	43,597	135.39
Other uses [2]	19,866	1,279,285	64.40	42,497	1,743,975	41.04
Total	52,465	2,941,550	56.07	56,926	3,410,597	59.91

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes well drilling, joint cement, miscellaneous uses, and uses indicated by footnote 1.

cial sand and gravel supplied 69 percent of the tonnage and 80 percent of the value, compared with 71 and 80 percent, respectively, in 1962. Commercial sand increased 11 percent in tonnage and 12 percent in value, and Government-and-contractor sand decreased 13 percent in tonnage and 15 percent in value. Commercial gravel decreased 27 percent in tonnage and 21 percent in value, and Government-and-contractor gravel increased 27 and 10 percent in tonnage and value, respectively. Sand and gravel was produced in 87 counties. Commercial sand and gravel was produced in 16 counties, gravel only was produced in 11 counties, and sand only was produced in 8 counties. Forty-nine companies operated 62 pits in 35 counties compared with 67 pits in 39 counties in 1962. Government-and-contractor output of sand only occurred in 61 counties, gravel only in 1 county, and sand and gravel in 11 counties. Leading producers were Becker County Sand and Gravel Co., W. R. Bonsal Co. Inc., the lessees of B. V. Hedrick Gravel and Sand Co., and the North Carolina State Highway and Public Works Commission.

TABLE 5.—Sand and gravel sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Alexander	45,530	$15,962	55,515	$22,205
Alleghany	76,600	63,800		
Ashe	111,194	131,341	(1)	(1)
Avery			(1)	(1)
Beaufort	(1)	(1)	91,800	41,310
Bertie	6,334	3,800	7,180	1,795
Bladen	95,100	68,620	62,000	38,000
Brunswick	24,000	14,400	30,000	17,700
Buncombe	928,235	982,791	790,863	914,353
Burke	277,262	208,400	92,300	104,700
Cabarrus	42,325	18,265	240,915	263,787
Camden	12,500	7,500	23,500	13,860
Carteret	5,000	2,500	7,500	3,375
Caswell	16,400	16,400	10,000	10,000
Catawba	72,686	26,564	45,950	18,380
Chowan	1,200	720	90,698	53,500
Clay			32,350	27,000
Cleveland	(1)	(1)	154,872	100,720
Columbus	174,800	106,600	72,500	42,800
Currituck	44,000	26,400	42,500	25,000

TABLE 5.—Sand and gravel sold or used by producers, by counties—Continued

County	1962		1963	
	Short tons	Value	Short tons	Value
Dare			4,500	$2,700
Davidson	195,500	$97,750	290,000	145,000
Davie	64,000	38,400	52,000	31,200
Duplin	12,175	7,350	27,650	19,895
Edgecombe	65,200	44,920	169,750	133,400
Forsyth	84,100	51,180	(1)	(1)
Franklin	10,000	5,000	11,000	5,500
Gaston	62,774	25,109	39,500	15,800
Gates	38,000	22,800	15,500	9,100
Graham	(1)	(1)	125,000	100,000
Granville	7,200	5,325	5,310	5,628
Greene	72,400	36,200	30,631	13,783
Guilford	6,700	6,700	6,600	6,600
Hertford	102,291	61,370	25,493	15,000
Hoke	43,071	25,840	16,500	10,540
Hyde	1,800	450	2,500	1,500
Iredell	97,547	35,243	68,700	27,480
Jackson	(1)	(1)		
Johnston	48,500	45,650	48,200	45,880
Jones	25,976	12,988	32,250	14,512
Lee	191,290	132,770	253,144	211,800
Lincoln	66,970	26,788	53,250	21,300
Mitchell	(1)	(1)	27,534	28,510
Montgomery	78,000	28,410	77,500	27,125
Moore	545,748	365,089	643,004	490,131
New Hanover	8,000	4,800	15,000	8,850
Onslow	11,000	6,600	25,000	14,750
Pamlico	1,000	500	2,000	900
Pasquotank	10,000	6,000	20,000	11,800
Pender	11,000	6,600	28,000	16,500
Perquimans	14,100	8,460	19,000	11,200
Person	6,000	4,500	2,430	2,500
Pitt	136,138	82,579	114,783	68,965
Polk	(1)	(1)	98,000	44,860
Richmond	76,000	29,850	58,500	35,100
Robeson	374,500	403,100	135,000	82,050
Rockingham	1,240	1,240	2,100	2,100
Rowan	65,000	32,500	60,000	30,000
Rutherford	(1)	(1)	124,000	49,600
Sampson	148,000	115,800	170,000	136,800
Scotland	14,500	5,075	27,653	10,868
Stanly	4,500	4,500	15,000	8,900
Stokes	78,000	46,800	54,000	32,400
Surry	18,880	28,320	19,736	29,604
Union	20,000	15,000	30,000	22,500
Vance	5,000	2,500	5,000	2,500
Wake	5,162	3,613	3,850	2,695
Washington	2,500	1,500	11,300	6,600
Watauga	128,674	122,174	(1)	(1)
Wilkes	97,300	79,300	104,650	78,487
Wilson	90,005	53,210	72,350	56,997
Yadkin	8,760	13,140	7,335	11,002
Yancey	365,491	259,689	97,582	89,768
Undistributed [2]	7,062,566	7,350,538	5,829,279	6,183,243
Total	12,515,724	11,457,283	11,027,507	10,132,408

[1] Figure withheld to avoid disclosing individual company confidential data, included with "Undistributed."

[2] Includes Anson, Caldwell, Cherokee, Craven, Cumberland, Halifax, Harnett, Haywood, Henderson, Lenoir, Macon McDowell, Mecklenburg, Northampton, Transylvania, and Wayne Counties, and counties indicated by footnote 1.

Stone.—Output of stone, the principal mineral product of the State, decreased 19 percent in tonnage and 13 percent in value. Crushed stone production was down 19 percent in tonnage and 16 percent in value, but dimension stone increased 22 percent in quantity and 39 percent in value.

Crushed traprock production decreased 26 percent in tonnage and 18 percent in value, crushed granite decreased 19 percent in tonnage and value, and crushed limestone decreased 3 percent in tonnage with

TABLE 6.—Sand and gravel sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	2,134,329	$1,686,935	$0.79	2,682,306	$2,141,565	$0.80
Paving	2,973,431	1,755,660	.59	2,484,497	1,448,402	.58
Fill	425,086	265,621	.62	424,029	277,050	.65
Railroad ballast	127,435	109,572	.86	(1)	(1)	(1)
Other [2]	532,084	273,854	.51	538,692	268,830	.50
Total	6,192,365	4,091,642	.66	6,129,524	4,135,847	.67
Gravel:						
Paving	4,215,204	4,078,399	.97	2,741,386	2,760,408	1.01
Structural	1,540,826	2,315,079	1.50	1,579,331	2,193,476	1.39
Fill	20,000	18,800	.94	7,450	6,000	.81
Other [3]	547,329	953,363	1.74	569,816	1,036,677	1.82
Total	6,323,359	7,365,641	1.16	4,897,983	5,996,561	1.22
Total sand and gravel	12,515,724	11,457,283	.92	11,027,507	10,132,408	.92

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes blast, filtration, other uses, and uses indicated by footnote 1.
[3] Includes railroad ballast and other uses.

a slight increase in value. Crushed sandstone increased 22 percent in tonnage but decreased 17 percent in value, and crushed marble decreased 79 percent in tonnage and 20 percent in value. Production of dimension slate decreased 2 percent in tonnage and value, dimension marble increased 21 percent in tonnage but decreased 2 percent in value, and dimension granite output increased 26 percent in tonnage and 46 percent in value. Byproduct quartz was recovered from feldspar flotation plants in Mitchell County.

TABLE 7.—Crushed granite sold or used by producers, by uses

County	1962		1963	
	Short tons	Value	Short tons	Value
Cabarrus	(1)	(1)	86,060	$129,090
Caldwell			(1)	(1)
Cherokee	23,102	$57,755	13,205	31,111
Henderson			(1)	(1)
Jackson			(1)	(1)
Lincoln	(1)	(1)		
Macon	38,049	76,099	104,827	104,827
Madison			(1)	(1)
Orange	50,865	76,297	22,483	33,725
Polk			(1)	(1)
Rutherford			(1)	(1)
Transylvania	(1)	(1)		
Wilson	(1)	(1)		
Undistributed [2]	13,611,071	19,881,634	10,820,836	16,035,099
Total	13,723,087	20,091,785	11,047,411	16,333,852

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes Alamance, Buncombe, Caswell, Catawba, Forsyth, Gaston, Guilford, Iredell, Mecklenburg, Nash, Northampton, Pitt, Randolph, Rockingham, Rowan, Stokes, Surry, Swain, Vance, Wake, Wilkes and Yadkin Counties and counties indicated by footnote 1.

Stone was quarried in 46 counties: granite in 33, traprock in 11, limestone in 6, slate in Davidson and Montgomery, marble in Cherokee, and quartz in Mitchell and Montgomery. Commercial stone, excluding quartz, was produced by 28 operators from 78 quarries: 57 granite, 9 traprock, 8 limestone, 2 slate, and 2 marble. The State highway department crushed stone from seven granite and three traprock quarries. Leading crushed stone producers were Superior Stone Co., a division of Martin-Marietta Corp. (granite, traprock, and limestone); W. E. Graham & Sons, a division of Vulcan Materials Co. (granite); and Nello L. Teer Co. (granite, traprock, and limestone). Principal producers of dimension stone were North Carolina Granite Corp., Harris Granite Quarries, Jacob's Creek Stone Co. (slate), and Columbia Marble Co.

Talc and Pyrophyllite.—Combined production of crude talc and pyrophyllite increased 7 percent in tonnage and 3 percent in value. Ground talc and pyrophyllite increased 1 percent in tonnage but decreased 5 percent in value. Sawed talc (crayons) increased 15 percent in tonnage and 3 percent in value. Ground talc was sold principally for textile use and toilet preparations. Ground phyrophyllite was used principally in ceramics, refractories, insecticides, and rubber products. Talc was mined in Cherokee County, and pyrophyllite was mined in Alamance, Moore, and Orange Counties.

Vermiculite.—Zonolite Co. operated an exfoliating plant at High Point, Guilford County, using crude vermiculite shipped into the State.

METALS

Gold, Silver, Copper, Lead, and Zinc.—Copper production decreased over 99 percent in tonnage and value, gold decreased 93 percent in quantity and value, lead decreased 72 percent in tonnage and 67 percent in value, and silver decreased 73 percent in quantity and 69 percent in value. Gold was recovered at Union Refining & Mining Co.'s Star mine near High Point. Gold, silver, copper, lead, and zinc were recovered from Tungsten Mining Corp.'s operations in Vance County. The Tungsten Mining Corp. closed its mine early in 1963.

Iron Ore.—Cranberry Magnetite Corp. shipped a small quantity of magnetite from its Cranberry mine for use as a heavy aggregate in concrete. Production decreased 33 percent in tonnage and 23 percent in value.

Tungsten.—The Hamme mine and mill of Tungsten Mining Corp., a division of Howe Sound Co., near Henderson in Vance County, ceased operations in February. The cessation of operations was due to the low price of tungsten.

REVIEW BY COUNTIES

Ninety-seven of the 100 counties reported mineral production; Cleveland, Mitchell, Guilford, Forsyth, Anson, and Rowan were the leading counties. In addition to the detailed production listed in table 8, substantial quantities of mica and crude feldspar—of undetermined county origin—were produced. Only those counties with significant production or activity in the mineral industry are discussed; see table 8 for additional details.

Alamance.—Superior Stone Co., a division of Martin Marietta Corp. (Burlington quarry), and North Carolina State Highway and Public Works Commission (Bason quarry) crushed granite for concrete and roads. Boren & Harvey, Inc., mined pyrophyllite for refractory and ceramic uses at the Snow Camp mine. Hanford Brick Co. Inc. (Hanford mine) mined miscellaneous clay for heavy clay products. Allison Rock & Novelties and Bill Wall collected a small quantity of gem stones (pyrophyllite and quartz).

Alexander.—The State highway commission mined paving sand. John Frye and T. R. McKenzie collected a small quantity of gem stones (smoky quartz).

TABLE 8.—Value of mineral production in North Carolina, by counties [1]

County	1962	1963	Minerals produced in 1963 in order of value
Alamance	(2)	(2)	Granite, pyrophyllite, miscellaneous clay, gem stones.
Alexander	$16,017	$22,235	Sand and gravel, gem stones.
Alleghany	(2)	75	Gem stones.
Anson	(2)	(2)	Sand and gravel.
Ashe	(2)	(2)	Sand and gravel, gem stones.
Avery	(2)	(2)	Mica, kaolin, iron ore, sand and gravel, gem stones.
Beaufort	(2)	41,310	Sand and gravel.
Bertie	3,800	1,795	Do.
Bladen	68,620	38,000	Do.
Brunswick	14,400	17,700	Do.
Buncombe	(2)	(2)	Sand and gravel, granite, gem stones.
Burke	208,400	104,925	Sand and gravel, gem stones.
Cabarrus	(2)	(2)	Sand and gravel, traprock, granite, gem stones.
Caldwell	(2)	(2)	Sand and gravel, granite.
Camden	7,500	13,860	Sand and gravel.
Carteret	2,500	3,375	Do.
Caswell	(2)	(2)	Granite, sand and gravel.
Catawba	(2)	(2)	Granite, miscellaneous clay, sand and gravel.
Chatham	448,812	481,220	Miscellaneous clay, traprock.
Cherokee	(2)	(2)	Marble, sand and gravel, talc, granite.
Chowan	720	53,500	Sand and gravel.
Clay	2,100	27,000	Do.
Cleveland	(2)	(2)	Lithium minerals ,limestone, traprock, mica, sand and gravel, feldspar, gem stones.
Columbus	106,600	42,800	Sand and gravel.
Craven	(2)	(2)	Limestone, sand and gravel.
Cumberland	(2)	(2)	Sand and gravel, miscellaneous clay.
Currituck	26,400	25,000	Sand and gravel.
Dare	----------	2,700	Do.
Davidson	(2)	(2)	Traprock, sand and gravel, slate, miscellaneous clay gem stones.
Davie	38,400	31,300	Sand and gravel, gem stones.
Duplin	7,350	19,895	Sand and gravel.
Durham	(2)	(2)	Traprock, miscellaneous clay, gem stones.
Edgecombe	44,920	133,400	Sand and gravel.
Forsyth	(2)	(2)	Granite, sand and gravel.
Franklin	5,000	5,500	Sand and gravel.
Gaston	(2)	(2)	Granite, sand and gravel, gem stones.
Gates	22,800	9,100	Sand and gravel.
Graham	(2)	100,000	Do.
Granville	5,325	5,638	Sand and gravel, gem stones.
Greene	36,200	13,783	Sand and gravel.
Guilford	(2)	(2)	Granite, traprock, miscellaneous clay, sand and gravel, gem stones.
Halifax	(2)	(2)	Sand and gravel, miscellaneous clay, gem stones.
Harnett	(2)	(2)	Sand and gravel, miscellaneous clay.
Haywood	(2)	(2)	Sand and gravel, gem stones.
Henderson	(2)	574,229	Limestone, granite, sand and gravel, mis cellaneous clay
Hertford	61,370	15,000	Sand and gravel.
Hoke	25,840	10,540	Do.
Hyde	450	1,500	Do.
Iredell	(2)	(2)	Granite, sand and gravel.
Jackson	(2)	(2)	Olivine, granite, gem stones.
Johnston	(2)	(2)	Traprock, sand and gravel, miscellaneous clay, gem stones.
Jones	12,988	14,512	Sand and gravel.
Lee	(2)	(2)	Miscellaneous clay, sand and gravel.
Lenoir	(2)	(2)	Sand and gravel.
Lincoln	(2)	21,840	Sand and gravel, gem stones.

See footnotes at end of table.

TABLE 8.—Value of mineral production in North Carolina, by counties[1]—Continued

County	1962	1963	Minerals produced in 1963 in order of value
Macon	354,523	(2)	Granite, sand and gravel, mica, gem stones.
Madison	----------	(2)	Granite.
McDowell	(2)	(2)	Sand and gravel.
Mecklenburg	(2)	(2)	Granite, sand and gravel, gem stones.
Mitchell	3,387,677	3,167,493	Feldspar, mica, sandstone, sand and gravel, gem stones.
Montgomery	(2)	(2)	Sand and gravel, slate, miscellaneous clay, sandstone, gold, gem stones, silver.
Moore	(2)	(2)	Sand and gravel, pyrophyllite, miscellaneous clay, gem stones.
Nash	(2)	(2)	Granite.
New Hanover	4,800	(2)	Cement, limestone, miscellaneous clay, sand and gravel.
Northampton	(2)	(2)	Sand and gravel, granite.
Onslow	(2)	(2)	Limestone, sand and gravel.
Orange	(2)	(2)	Pyrophyllite, granite, gem stones.
Pamlico	500	900	Sand and gravel.
Pasquotank	6,000	11,800	Do.
Pender	6,600	16,500	Do.
Perquimans	8,460	11,200	Do.
Person	4,500	2,500	Do.
Pitt	(2)	(2)	Granite, sand and gravel.
Polk	(2)	(2)	Do.
Randolph	(2)	(2)	Granite.
Richmond	29,850	35,100	Sand and gravel.
Robeson	403,100	82,050	Do.
Rockingham	(2)	(2)	Granite, miscellaneous clay, sand and gravel, traprock.
Rowan	(2)	(2)	Granite, miscellaneous clay, sand and gravel.
Rutherford	(2)	(2)	Granite, sand and gravel, gem stones.
Sampson	138,180	151,640	Sand and gravel, miscellaneous clay.
Scotland	5,075	10,868	Sand and gravel.
Stanly	348,072	350,628	Miscellaneous clay, traprock, sand and gravel, gem stones.
Stokes	(2)	(2)	Miscellaneous clay, sand and gravel, granite, gem stones.
Surry	(2)	(2)	Granite, traprock. sand and gravel.
Swain	(2)	(2)	Limestone, granite, feldspar.
Transylvania	(2)	(2)	Sand and gravel, gem stones.
Union	(2)	(2)	Traprock, miscellaneous clay, sand and gravel.
Vance	(2)	(2)	Granite, tungsten, silver, lead, copper, zinc ore, sand and gravel, gold.
Wake	(2)	(2)	Granite, sand and gravel.
Washington	1,500	6,600	Sand and gravel.
Watauga	122,174	(2)	Sand and gravel, granite.
Wayne	(2)	(2)	Sand and gravel.
Wilkes	(2)	78,487	Do.
Wilson	(2)	(2)	Granite, sand and gravel.
Yadkin	(2)	(2)	Do.
Yancey	(2)	(2)	Mica, sand and gravel, olivine, asbestos, feldspar, gem stones.
Undistributed	48,609,477	39,136,502	
Total	54,597,000	44,894,000	

[1] Martin, Tyrrell, and Warren Counties are not listed because no production was reported.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Anson.—Anson County ranked fifth in the State in value of mineral production. W. R. Bonsal Co., Inc. (Bonsal mine), the lessees of B. V. Hedrick Gravel and Sand Co. (Lilesville mine), and the State highway commission mined sand and gravel for structural, paving, railroad ballast, and other uses.

Ashe.—Maymead Lime Co. Inc. (Buffalo and Glendale mines) mined paving gravel. Ruth Stanley and Stephen B. Whitlow collected small quantities of gem stones (beryl, green and smoky quartz, native copper, malachite, and gadelinite).

Avery.—Cranberry Magnetite Corp. shipped a small quantity of magnetite from the Cranberry mine. Harris Clay Co. (Gushers Knob mine) was the only producer of scrap mica. English Mica Co. and Harris Clay Co. ground mica for paint, rubber, wallpaper, plastics,

roofing, joint cement, and other uses. Harris Clay Co. mined kaolin at the Gusher Knob mine for refractory uses and also mined paving sand. Leon McCluer and Albert Plaag collected small quantities of gem stones (epidote).

Beaufort.—The State highway commission mined sand for paving and other uses. Texas Gulf Sulphur Co. started excavation of an experimental phosphate rock pit with a floating dredge placed in operation in mid-1963. A pilot processing plant also was completed, and treatment of dredged phosphate rock was expected to begin near the end of the year.

Buncombe.—Six operators mined sand and gravel for structural, paving, and fill uses; the leading producers were Grove Stone Sand Branch (Grove mine) and Western Stone Co. Inc. (Asheville mine). W. E. Graham & Sons, a division of Vulcan Materials Co., crushed granite for concrete and roads at the Enka quarry. Asheville Mica Co. ground mica for rubber and joint cement uses. Mrs. Mae Culberson and J. F. Broyles, Jr., collected small quantities of gem stones (moonstone and quartz).

Burke.—A. R. Thompson, contractor, A. P. Causby Sand & Stone Co., and the State highway commission mined sand and gravel for structural and paving uses. Great Lakes Carbon Corp. manufactured carbon and graphite products at the Morgantown plant. Wayne J. Morgan collected a small quantity of gem stones (moonstone and ruby).

Cabarrus.—White Gravel Co. Inc., Poplar Tent Gravel Pit, R. L. Holt Co. (Concord mine), and the State highway commission mined sand and gravel for paving uses. Young Stone Co. (Gold Hill quarry) crushed granite for concrete, roads, and other uses. The State highway commission crushed granite for concrete and roads at the Lee White quarry. Science Hobbies (dealers) and Blake Stephens collected small quantities of gem stones (amethysts, pyromorphite, and quartz crystals).

Caldwell.—Miller Bros. Co., Carl W. Clement Construction Co., Inc., and the State highway commission mined sand and gravel for structural and paving uses. Carl W. Clement Construction Co. Inc. crushed granite for concrete and roads.

Caswell.—W. E. Graham & Sons (Shelton quarry) and the State highway commission produced granite for riprap, concrete, roads, and railroad ballast. The State highway commission mined paving sand.

Catawba.—Superior Stone Co. (Hickory quarry) crushed granite for concrete and roads. Statesville Brick Co. (Statesville mine) mined miscelaneous clay for heavy clay products. The State highway commission mined paving sand.

Chatham.—Cherokee Brick Co. of North Carolina (Brickhaven mine), Boren Clay Products Co. (Gulf mine), Pomona Terra Cotta Co., and Sanford Corp. mined miscellaneous clay for heavy clay products. The State highway commission crushed traprock for concrete and roads at the Goldston quarry.

Cherokee.—Columbia Marble Co. (Pleasant Valley quarry) quarried dimension marble for rough interior, sawed and cut interior building stone, and cut and dressed monumental stone. Universal Materials Corp. and Columbia Marble Co. crushed marble for terazzo and other

uses. Macon Construction Co. mined paving gravel. Hitchcock Corp. (Nancy Jordan mine) mined talc for textiles, toilet preparations, and other uses. The State highway commission crushed granite for concrete and roads at the Carringer and Dockery quarries.

Cleveland.—Cleveland County ranked first in the State in value of mineral production. Superior Stone Co. crushed limestone at the Kings Mountain quarry and crushed traprock at the Kings Mountain No. 2 quarry for concrete and roads. Shelby Sand & Stone Inc. (First Broad River mine) and the State highway commission mined sand for structural, paving, and fill uses. Kings Mountain Mica Co. Inc. (Moss and Patterson mines), Western Mica of North Carolina (Industrial mine), and Foote Mineral Co. (Kings Mountain mine) produced scrap mica. Foote Mineral Co. at Kings Mountain mined and milled lithium minerals and also produced a quantity of byproduct feldspar for glass. Small quantities of gem stones were collected (jade, spodumene, gold, quartz, garnet, feldspar, aquamarine, and corundum).

Columbus.—Riegel Carolina Corp. recovered quicklime at the Acme Paper Mill. The State highway commission mined sand for paving and fill uses.

Craven.—Superior Stone Co. (New Bern quarry) and Nello L. Teer Co. crushed limestone for concrete and roads. Southern Sand Co. Inc. (New Bern mine) and the State highway commission mined sand for structural and stabilization uses.

Cumberland.—Becker County Sand & Gravel Co. (Fayetteville mine) and the State highway commission mined sand and gravel for structural, paving, and fill uses. Ideal Brick Co. Inc. (Linden mine) mined miscellaneous clay for heavy clay products.

Davidson.—Superior Stone Co. (Lexington quarry) crushed traprock for concrete and roads. Jacob's Creek Stone Co. Inc. (Flagstone quarry) quarried dimension slate for structural millstock and flagging. Cunningham Brick Co. (Thomasville mine) mined miscellaneous clay for heavy clay products. The State highway department mined paving sand and gravel. John Frye collected a small quantity of gem stones (siderite).

Davie.—The State highway commission mined paving sand. Stephen Whitlow collected a small quantity of gem stones (columbite).

Durham.—Nello L. Teer Co. crushed traprock for concrete and roads. Borden Brick & Tile Co. and Tri-Angle Brick Co. mined miscellaneous clay for heavy clay products. Dr. Charles W. Horton and T. R. McKenzie collected small quantities of gem stones (chalcedony and jasper).

Edgecombe.—Quality Sand & Gravel Co. (Rocky Mount mine), Tar River Sand & Gravel (Whitehurst mine), and the State highway commission mined sand and gravel for structural, paving, fill, and other uses.

Forsyth.—Forsyth County ranked fourth in the State in total value of mineral production. W. E. Graham & Sons (South Fork, 421, Piedmont, and North quarries) produced granite for riprap, concrete, and roads. Ira Pope & Sons Inc. (Yadkin River mine), Paul Miller (Miller mine), and the State highway commission mined sand for structural and paving uses.

Gaston.—Superior Stone Co. (Gaston quarry) crushed granite for concrete and roads. The State highway commission mined paving sand. Small quantities of gem stones were collected (quartz crystals, graphite, corundum, hematite, kyanite, rutile, lazulite, and hiddenite).

Granville.—The State highway commission mined sand for snow and ice control use. John Frye collected a small quantity of gem stones (jasper).

Guilford.—Guilford County ranked third in the State in total value of mineral production. Superior Stone Co. (Buchanan, Jamestown, and Pomona quarries) and W. E. Graham & Sons (Stokesdale quarry) crushed granite for concrete, roads, and railroad ballast. Superior Stone Co. (Hicone quarry) crushed traprock for concrete and roads. Boren Clay Products Co. (Pleasant Garden mine) mined miscellaneous clay for heavy clay products. The State highway commission mined paving sand. Zonolite Co. exfoliated vermiculite at the High Point plant. Don Charlton collected a small quantity of gem stones (quartz).

Halifax.—Superior Stone Co. (Weldon mine) and the State highway commission mined sand and gravel for structural, paving, and stabilization uses. Nash Brick Co., Inc. (Ita and Page mines), mined miscellaneous clay for use in heavy clay products. Albemarle Paper Manufacturing Co. recovered quicklime at the Roanoke Rapids Mill. Allison Rocks & Novelties collected a small quantity of gem stones (ferrimolybdite).

Harnett.—Becker County Sand & Gravel Co. (Senter mine), Nello L. Teer Co. (Erwin mine), and the State highway commission mined sand and gravel for structural, paving, railroad ballast, fill, and other uses. Norwood Brick Co. (Lillington mine) mined miscellaneous clay for use in heavy clay products.

Haywood.—A. M. Sale, Inc. (Waynesville mine), and Rock Products Inc. (Blue Ridge Parkway mine), mined sand and gravel for paving. Champion Papers, Inc., recovered quickline at the Canton mill. Small quantities of gem stones were collected (corundum, blue sapphire, sugar quartz, and epidote).

Henderson.—Cogdill Limestone Co. (Cogdill quarry) and Fletcher Limestone Co. Inc. (Fletcher quarry) crushed limestone for concrete and roads. Rock Products, Inc. (Corn quarry) crushed granite for concrete and roads. Western Stone Co. Inc. mined paving gravel. Moland-Drysdale Corp. (Fletcher mine) mined miscellaneous clay for use in heavy clay products.

Iredell.—Superior Stone Co. (Statesville quarry) and Gilbert Engineering Co. crushed granite for concrete and roads. The State highway commission mined paving sand.

Jackson.—Harbison-Walker Refractories Co. (Addie mine) and Balsam Gap Co. (Balsam Gap mine) mined olivine for refractories. Rock Products, Inc. (Dillsboro quarry), crushed granite for concrete and roads. Dr. J. Dan Williams and Mrs. Mae Culberson collected small quantities of gem stones (aquamarine, crystal and smoky quartz, olivine, and magnetite).

Johnston.—Nello L. Teer Co. (Princeton quarry) produced traprock for riprap, concrete, roads, and railroad ballast. The State highway commission mined paving sand. Crumpler Brick & Tile Co. mined

miscellaneous clay for use in heavy clay products. Don Charlton collected a small quantity of gem stones (petrified wood).

Lee.—Sanford Brick & Tile Co. Inc., Lee Brick & Tile Co., Borden Brick & Tile Co., and Hanford Brick Co. mined miscellaneous clay for use in heavy clay products. The State highway commission mined paving sand and gravel.

Lenoir.—Barrus Construction Co. (Kinston mine) and the State highway commission mined sand and gravel for structural, paving, fill, and other uses.

Lincoln.—Several small quantities of gem stones were collected (iron ore, amethysts, andalusite, quartz crystal, and blue sapphire). The State highway commission mined sand for paving.

Macon.—Franklin Construction Co. (Tubb Mill quarry) crushed granite for concrete and roads. Rock Products, Inc. (Dills mine), mined paving gravel. A & C Mica Co. (Sheppard Knob mine), was the leading producer of scrap mica. Franklin Mineral Products Co. ground mica for paint, rubber, wallpaper, plastic, joint cement, and other uses. Several small quantities of gem stone were collected (ruby, sapphire, beryl, corundum, rhodolite, staurolite, rhodonite, garnet, pyrite, and iceland spar).

McDowell.—Becker County Sand & Gravel Co. (Marion mine), Pete Ellis (Spruce Pine mine), E. P. Boyd, and the State highway commission mined sand and gravel for structural and paving uses.

Mecklenburg.—Superior Stone Co. (Charlotte, Davidson, and Pineville quarries) crushed granite for concrete and roads. H. D. Bartlett Sand Co. (Charlotte mine) mined structural sand. Joe Leonhardt and L. Rex Boone collected small quantities of gem stones (epidote, leopardite, and malachite).

Mitchell.—Mitchell County ranked second in the State in value of mineral production. Five operators produced crude feldspar from seven mines; the leading producers were International Minerals & Chemical Corp. (Hawkins mine) and The Feldspar Corp. (Poteat, Wiseman, and Sullins mines). Ground feldspar for enamel, pottery, glass, filler, and tile uses was produced by International Minerals & Chemical Corp., and Lawson-United Feldspar and Minerals Co. crushed sandstone (quartz) recovered from feldspar milling. The leading producers of scrap mica were Southern Mica Co. of North Carolina (Bailey mine), The Feldspar Corp. (Poteat and Wiseman mines), and International Minerals & Chemical Corp. Four companies ground mica for roofing, paint, rubber, wallpaper, plastics, and other uses; the leading producer was Carolina-Southern Mining Co. Inc. Crabtree Stone & Gravel Co. (Crabtree mine) mined paving gravel. Several small collections of gem stones were reported (epidote, garnet, hyalite, emerald, gummite, uraninite, unakite, moonstone, aquamarine, and uranite).

Montgomery.—Union Refining & Mining Co. recovered gold and silver at the Star mine. Jacob's Creek Stone Co. Inc. (Edenboro quarry) quarried dimension slate for structural millstock and flagging. Mt. Gilead Brick Co. mined miscellaneous clay for heavy clay products. Thomas & Woody Mining Co. crushed sandstone for concrete and roads. The State highway commission mined paving sand. Dr. C. N. Eckerson, John Frye, and T. R. McKenzie collected small quantities of gem stones (quartz crystals, unakite, limonite, and uranite).

Moore.—Six operators mined sand and gravel for structural, paving, fill, and other uses. The leading producers were Pleasants Sand & Supply Co. (Pleasants mine) and Cumberland Gravel & Sand Co. (Vass mine). Standard Mineral Co. Inc. (Underground mine) and General Minerals Co. (Glendon mine) mined pyrophyllite for ceramics, insecticides, paint, paper, rubber, and plastics uses. Borden Brick & Tile Co., Ceramic Minerals, Inc. (Robbins mine), and T & H Clay Co. (Hancock mine) mined miscellaneous clay for heavy clay products. W. R. Viall, Sr., and John Frye collected small quantities of gem stones (quartz, pyrophyllite, and talc).

New Hanover.—Ideal Cement Co. began production of portland cement at the new Castle Hayne mill and mined limestone and miscellaneous clay at Wilmington for use in the cement plant. The State highway commission mined paving sand.

Northampton.—Superior Stone Co. (Garysburg mine) and the State highway commission mined sand and gravel for structural and paving uses. Nello L. Teer Co. (King quarry) crushed granite for concrete and roads.

Onslow.—Superior Stone Co. (Belgrade quarry) crushed limestone for concrete and roads. The State highway commission mined paving sand.

Orange.—Piedmont Minerals Co. Inc. (Hillsboro mine) mined pyrophyllite for ceramic and refractory purposes. Duke University quarried dimension granite for use as rubble at the Hillsboro quarry. The State highway commission crushed granite for concrete and roads at the Bacon quarry. Blue Ridge Minerals Museum (dealers) collected a small quantity of gem stones (pyrophyllite).

Pitt.—Superior Stone Co. (Fountain quarry) crushed granite for concrete and road uses. Concrete Products Co. (Greenville mine), White Concrete Co. Inc. (Munford mine), and the State highway commission mined sand for structural paving, and other uses.

Polk.—A. R. Thompson, contractor (Mill Spring quarry), crushed granite for concrete and road uses. The State highway commission mined paving sand and gravel.

Randolph.—Superior Stone Co. (Ashboro quarry) and the State highway commission (Parks Cross Road quarry) crushed granite for concrete and roads.

Rockingham.—Superior Stone Co. (Reidsville quarry) crushed granite for concrete and roads. Morris Hall (King's quarry) crushed traprock for concrete and roads. Virginia Solite Corp. (Leakesville mine) and Webster Brick Co. Inc. (Draper mine) mined miscellaneous clay for lightweight aggregates and heavy clay products. The State highway commission mined paving sand.

Rowan.—Rowan County ranked sixth in the State in total value of mineral production. Seven quarries produced dimension granite for use as rough architectural stone, dressed construction stone, rough and dressed monumental stone, curbing and flagging, and paving blocks. The leading producer was Harris Granite Quarries Co. (Balfour, Collins, and Shuping quarries). Superior Stone Co. (Woodleaf quarry) and Harris Granite Quarries Co. (Balfour and Collins quarries) produced granite for riprap, concrete and roads. Isenhour Brick & Tile Co. (East Spencer mine) and Carolina Tuff-Lite Corp.

(Tuff-Lite mine) mined miscellaneous clay for heavy clay products and lightweight aggregates. The State highway commission mined sand for paving. Carolina Perlite Co. Inc. expanded perlite at the Gold Hill plant. Gardner Granite Works produced millstones.

Rutherford.—A. R. Thompson, contractor (Cliffside quarry), crushed granite for concrete and roads. The State highway commission mined paving sand. R. D. Groves collected a small quantity of gem stones (corundum).

Sampson.—Williams Sand & Gravel Co. (Williams mine) and the State highway commission mined sand and gravel for structural and paving uses. Sampson Brick Co. Inc. and Patterson Brick Co. mined miscellaneous clay for heavy clay products.

Stanly.—Carolina Solite Corp. (Aquadale mine), Yadkin Brick Yards, Inc., and Stanley Shale Products Co. (Norwood mine) mined miscellaneous clay for lightweight aggregates and heavy clay products. The State highway commission crushed traprock for concrete and roads at the McManus quarry and also mined paving sand. John E. Canhum and Robert Fulton collected small quantities of gem stones (quartz and pyrite). Aluminum Company of America produced primary aluminum at its smelter at Badin.

Stokes.—Pine Hall Brick & Pipe Co. (No. 1 mine) mined miscellaneous clay for heavy clay products. W. E. Graham & Sons crushed granite for concrete and roads at the Sandy Ridge quarry. The State highway commission mined paving sand. Blue Ridge Minerals Museum collected a small quantity of gem material (sandstone).

Surry.—North Carolina Granite Corp. (Mount Airy quarry) quarried dimension granite for rubble, rough construction stone, rough and dressed architectural stone, rough and dressed monumental stone, curbing and flagging, and paving blocks. W. E. Graham & Sons (Elkins, Mount Airy, and Pilot Mountain quarries) and North Carolina Granite Corp. produced granite for riprap, concrete, roads, and poultry grit. Arrat Products Co. (Surry quarry) crushed traprock for concrete and roads. The State highway commission mined paving sand.

Swain.—Nantahala Talc & Limestone Co. (Hewitt quarry) crushed limestone for concrete, roads, railroad ballast, and agstone. J. L. Colville Construction Co. (Colville quarry) crushed granite for concrete and roads. The Feldspar Corp. mined a small quantity of crude feldspar at the Alexander mine.

Transylvania.—Western Stone Co. Inc., Fred McCrary, and Siniard Brothers mined sand and gravel for structural and paving uses. Dr. J. Dan Williams collected a small quantity of gem stones (beryl).

Union.—Superior Stone Co. (Bakers quarry) and the State highway commission (Monroe quarry) crushed traprock for concrete and roads. Kendrick Brick & Tile Co. (Monroe mine) mined miscellaneous clay for heavy clay products. The State highway commission mined paving sand.

Vance.—Tungsten Mining Corp. mined tungsten ore at the Hamme mine and also recovered copper, gold, lead, silver, and zinc ore from tungsten mill tailings; during February the mine closed due to low price of tungsten. W. E. Graham & Sons (Greystone quarry) pro-

duced granite for riprap, concrete, roads, and railroad ballast. The State highway commission mined sand for snow and ice control.

Wake.—Superior Stone Co. (Knightdale, Crabtree, and Garner quarries) and Nello L. Teer Co. (Raleigh quarry) produced granite for riprap, concrete, and roads. The State highway commission mined paving sand.

Washington.—The State highway commission mined paving sand. Weyerhaeuser Co. recovered quicklime at the Plymouth Paper Mill.

Watauga.—Maymead Lime Co. Inc. (Maymead mine) and Clark, Anderson & Guy (Boone mine) mined paving gravel. C. M. Shore, Jr., quarried dimension granite for rough construction stone.

Wayne.—Superior Stone Co. (Goldsboro mine) and the State highway commission mined sand and gravel for structural and paving uses.

Wilkes.—Clark, Anderson & Guy (Wilkesboro mine) and the State highway commission mined sand and gravel for paving uses.

Wilson.—Superior Stone Co. (Elm City and Neverson quarries) crushed granite for concrete and roads. Gray Concrete Pipe Co. Inc. (Stantonsburg mine), Deans Sand Co. (Wilson mine), and the State highway commission mined sand and gravel for structural, paving, fill, and stabilization uses.

Yadkin.—W. E. Graham & Sons (Cycle quarry) crushed granite for concrete and roads. The State highway commission mined paving sand.

Yancey.—Deneen Mica Co. (Kenneth Hall mine), Hassett Mining Co. (Simpson mine), and Canada Mica Co. (Barger mine) produced scrap mica. Deneen Mica Co. and Hassett Mining Co. ground mica for roofing, well drilling, and joint cement uses. The Feldspar Corp. mined crude feldspar at the Bacchus mine and ground feldspar at the Burnsville plant for pottery uses. Clark, Anderson & Guy (Burnsville mine) and Yancey Sand & Gravel Co. (Fox mine) mined sand and gravel for structural and paving uses. Wiseman Mining Co. Inc. (Wray mine) and Georgia Talc Co. (Spruce Pine mine) mined olivine for refractory uses. Powhatan Mining Co. mined asbestos at the Burnsville mine. Mrs. Walker Ledford and W. J. Martin collected a small quantity of gem stones (beryl.)

The Mineral Industry of North Dakota

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the State Geological Survey of North Dakota for collecting information on all minerals except fuels.

By D. H. Mullen [1]

MINERAL production of North Dakota, valued at $94.5 million, was $3.9 million (4 percent) above the $90.6 million recorded in 1962. Output of mineral fuels—coal (lignite), natural gas, natural gas liquids, and crude petroleum—was valued at $84.2 million, slightly more than that of 1962, and represented 89 percent of the total value of mineral production in the State.

Gains in production were reported for all of the mineral fuels excepting lignite coal and crude petroleum, which declined 12 and 1 percent, respectively, below that of 1962.

Production of salt and crushed stone increased, whereas the output of clays and sand and gravel declined. The value of sand and gravel production increased substantially because of greater preparation of the material, most of which was used for road construction.

The output of uranium from the uranium-bearing lignites of Billings and Slope Counties increased manyfold over that of 1962. The

TABLE 1.—Mineral production in North Dakota [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	98	$124	[2] 5	[2] $10
Coal (lignite) do	2,733	6,135	2,399	5,250
Gem stones	(3)	1	(3)	1
Natural gas million cubic feet	25,155	3,446	32,798	6,264
Natural gas liquids:				
LP gases thousand gallons	68,881	2,665	79,653	3,166
Natural gasoline and cycle products do	16,872	1,085	20,511	1,339
Petroleum (crude) thousand 42-gallon barrels	25,181	69,248	[4] 24,957	[4] 68,133
Sand and gravel thousand short tons	9,615	7,122	9,529	9,193
Stone do	19	19	132	132
Uranium short tons	(5)	(5)	5,567	141
Value of items that cannot be disclosed: Salt, peat (1963), and value indicated by footnote 5		774		875
Total		[6] 90,619		94,504

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes bentonite and miscellaneous clay, included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Preliminary figures.
[5] Figure withheld to avoid disclosing individual company confidential data.
[6] Revised figure.

[1] Mining engineer, Bureau of Mines, Denver, Colo.

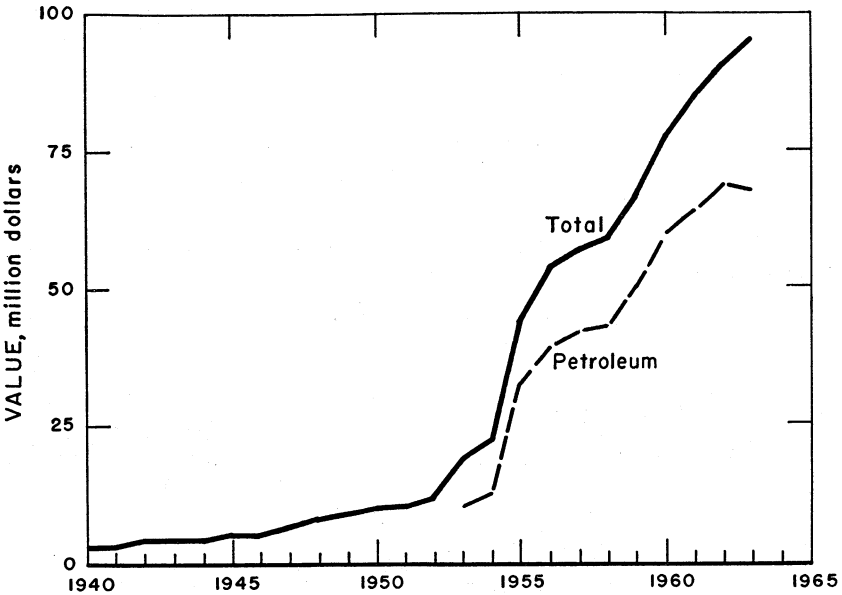


FIGURE 1.—Value of petroleum, 1953–63, and total value of mineral production in North Dakota, 1940–63.

lignite was burned in place and stationary and portable burning plants were built. The resulting ash was more amenable to the processes at established uranium mills and provided the necessary outlet for the uranium-bearing material.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$12,878	1958	$59,456
1953	20,736	1959	68,099
1954	23,510	1960	78,641
1955	47,574	1961	84,485
1956	57,215	1962	89,120
1957	56,098	1963	90,553

Water.—The Bureau of Mines conducted a canvass of the consumption of water in the mineral industries in 1962. Based on responses, the data also include estimates where necessary.

TABLE 3.—Water used during 1962 in the mineral industry, by type of operation

(Million gallons)

Type of operation [1]	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Nonmetal mines and mills	38		38	20	18	42.39
Sand and gravel operations	2,074	3,372	5,446	2,020	54	262.47
Natural gas processing plants	78	1,673	1,751	68	10	24.00
Total	2,190	5,045	7,235	2,108	82	
Oil- and natural-gas-well drilling			67			
Secondary-recovery operations			1,135			
Total			1,202			
Grand total			8,437			

[1] Water survey did not include cement plants, lime plants, metal smelters, metal refineries, petroleum refineries, natural-brine operations, sand and gravel operations using suction dredges without preparation plants, stockpile operations, and assessment work operations.

TABLE 4.—Water used during 1962 for wells drilled, by counties

County	Number of wells	Total footage drilled (feet)	Fresh water used (barrels)	Saline water used (barrels)	Total water used (barrels)	Total barrels per foot
Billings	3	24,569	24,569		24,569	1.00
Bottineau	69	269,822	126,816		126,816	.47
Bowman	20	169,640	163,787	400,000	563,787	3.32
Burke	44	279,018	142,299		142,299	.51
Divide	5	39,351	39,351		39,351	1.00
Dunn	3	31,148	46,099		46,099	1.48
McHenry	12	46,435	68,724		68,724	1.48
McKenzie	16	154,979	154,979		154,979	1.00
McLean	2	10,456	15,475		15,475	1.48
Mountrail	3	26,615	11,258	42,221	53,479	2.01
Oliver	1	7,500		7,500	7,500	1.00
Renville	21	94,109	139,281		139,281	1.48
Rolette	1	2,900	4,292		4,292	1.48
Sargent	1	1,214	1,797		1,797	1.48
Stark	1	10,150	15,022		15,022	1.48
Ward	7	34,475	51,023		51,023	1.48
Williams	17	142,530	132,553	9,977	142,530	1.00
Total	226	1,344,911	1,137,325	459,698	1,597,023	[1] 1.19

[1] Average.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Lignite).—The output of coal (lignite) was 12 percent below that of 1962, and the value dropped by 14 percent. Knife River Coal Mining Co., a subsidiary of Montana-Dakota Utilities Co., began operating its South Unit near Beulah in September. Output of the South Unit—as well as that of the older North Unit, also near Beulah—was used at the Montana-Dakota Utilities Co. thermal powerplants at Beulah, Mandan, and Hoot Lake, Minn. Baukol-Noonan, Inc., opened a new strip mine 6 miles east of Noonan, near Larson, and closed its old strip mine 1 mile east of Noonan. A $500,000 tipple was built, and all activities were transferred to the Larson site.

A 66-megawatt addition to the R. M. Heskett powerplant at Mandan, dedicated in October, raised the capacity of the plant to 100 megawatts; provisions were made to increase the capacity of the plant to 500 megawatts, as energy requirements demand.

TABLE 5.—Coal (lignite) production, by counties

(Excludes mines producing less than 1,000 short tons)

County	1962		1963	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Adams	20,846	$2.62	[2] 274,307	[2] $2.42
Bowman	192,782	1.88	165,112	1.89
Burke	398,499	2.37	283,324	2.31
Burleigh	10,734	3.32	(2)	(2)
Divide	229,907	2.46	(2)	(2)
Dunn	3,959	2.92	3,714	2.92
Grant	23,841	3.03	19,590	3.05
Hettinger	2,580	3.70	3,487	4.36
McLean	84,568	3.19	61,299	3.28
Mercer	1,042,475	2.14	1,042,578	2.06
Morton	[3] 20,394	[3] 2.56	12,784	2.60
Mountrail	(3)	(3)		
Oliver	11,612	2.50	7,623	2.50
Stark	92,916	1.81	68,778	1.57
Ward	595,682	2.22	454,512	2.23
Williams	2,059	4.70	1,880	4.60
Total	2,732,854	2.24	2,398,988	2.19

[1] Value received or charged f.o.b. mine, including selling cost. (Includes a value for coal not sold but used by producer, such as mine fuel and coal coked, as estimated by producer at average prices that might have been received if such coal had been sold commercially.)
[2] Production of Burleigh and Divide Counties combined with Adams County to avoid disclosing individual company confidential data.
[3] Production of Mountrail County combined with Morton County to avoid disclosing individual company confidential data.

On June 22, Basin Electric Power Cooperative began constructing a 200-megawatt lignite-burning powerplant at Stanton. At yearend the 144- by 240-foot concrete foundation had been completed and structural steel erection had begun. The Rural Electrification Administration granted a $39.2 million loan to United Power Association of Minnesota for constructing a 150-megawatt lignite-burning powerplant adjacent to the 200-megawatt Basin Electric Power Cooperative plant at Stanton. Kaiser Engineering Co., Oakland, Calif., was selected by the United Power Association to design and supervise the construction of the plant. Operation of the two plants was estimated to require an increase of 65 percent in the output of lignite.

The "Native Fuel Law" passed in 1891 requires that various State institutions, county buildings, and public schoolhouses use fuels that are native to the State: lignite and products of oil and natural gas. Thus the North Dakota Board of Higher Education continued to use lignite at the State colleges and universities. Contracts for the delivery of 104,700 tons of lignite for use in State institutions were announced by the North Dakota Department of Accounts and Purchases.

The Bureau of Mines continued its long-range program at the Charles R. Robertson Lignite Research Laboratory at Grand Forks. The program included investigations in the constitution and funda-

mental properties of lignite, the utilization of lignite and its products, and the development of processes and techniques that would result in a greater use of lignite and its products.

Of significance were the continued investigations in the gasification of lignite and the production of synthesis gas that could be of commercial use.

Reports [2] on results of the programs were published.

Natural Gas.—Dry natural gas from 31 wells in the Cedar Creek field in Bowman County and oil-well gas processed at natural gas processing plants in Burke and Williams Counties increased 31 percent in quantity and 82 percent in value over that of 1962. Dry natural gas and residual gas from the processing plants were marketed through pipelines of the Montana-Dakota Utilities Co. Processing plants at Lignite in Burke County and at McGregor and Tioga in Williams County were operated the entire year.

Oil-well gas was delivered to the processing plants through an extensive pipeline gathering system along the Nesson anticline in Burke, Divide, and Williams Counties.

Natural Gas Liquids.—Natural gasoline, propane, and butane were recovered at natural gas processing plants at Lignite in Burke County and at McGregor and Tioga in Williams County. Elemental sulfur was recovered as a byproduct at the plants at Lignite and Tioga. Output at the three plants was 16 percent above that of 1962.

The natural gasoline was used as a blending stock at the refinery at Mandan. The butane and propane were stored in an underground storage facility at Mentor, Minn., and at Williston in caverns created by solution mining of salt.

Peat.—Production of peat at Turtle Mountain in Bottineau County was first reported in 1963. The dried product was used for soil conditioning.

Petroleum.—Petroleum output from 1,824 wells in 100 fields in 13 counties was slightly below that of 1962. Drilling also was below that of 1962. Although no discoveries were made in the first 6 months of 1963, six new fields and a new producing horizon were discovered in the last half of the year. Total number of wells drilled was 182, a drop of 47 compared with that of 1962. Completion of 63 exploratory wells was 29 less than in 1962; however, the 7 discoveries in the latter half of the year were double those of 1962, with a success ratio of 11 percent. Of the 182 wells completed, 84 were oil wells with an overall success ratio of 46 percent.

The outstanding discovery was the new producing horizon in the Red River (Ordovician) formation in the Scoria field in Billings County. This was the third producing formation in the Scoria field, with production from the Madison limestone in 1953, and later from the shallower Heath sandstone. Other discoveries were in Bottineau County (3), Renville (2), and Burke (1).

---

[2] Carpenter, H. C., P. L. Cottingham, C. M. Frost, and W. W. Fowkes. Hydrocracking Low-Temperature Tar From a North Dakota Lignite. BuMines Rept. of Inv. 6237, 1963, 13 pp.

Elder, James L., and Wayne R. Kube. Technology and Use of Lignite Proceedings: Bureau of Mines-University of North Dakota Symposium, Grand Forks, N. Dak., April 1961. BuMines Inf. Circ. 8164, 1963, 113 pp.

Refineries at Mandan and Williston were operated the entire year. Throughput was 15.8 million barrels of crude oil, a percent below that of 1962. Receipts of crude oil at refineries were almost entirely from North Dakota fields; 71,000 barrels was from fields in Montana. Interstate shipments, 7.8 million barrels, were through the Portal pipeline to Minnesota. A small quantity was shipped to Wyoming refineries.

TABLE 6.—Crude petroleum production, by counties[1]

(Thousand barrels)

County	1962	1963[2]	Principal fields in 1963 in order of production
Billings	647	650	Fryburg, Rocky Ridge.
Bottineau	2,674	2,427	Newburg, South Westhope, Wiley, Haas.
Bowman	884	1,068	Cedar Creek.
Burke	3,752	3,481	Rival, North Tioga, Black Slough, Portal, Lignite.
Divide	368	352	North Tioga, Stoneview.
Dunn	43	30	Lost Bridge.
McHenry	11	42	Pratt.
McKenzie	6,486	6,635	Antelope, Blue Buttes, Charlson, Clear Creek.
Mountrail	1,471	1,405	Tioga, White Earth.
Renville	1,972	1,842	Glenburn, Sherwood.
Stark	48	38	Dickinson.
Ward		14	Southwest Aurelia.
Williams	6,825	6,973	Beaver Lodge, Tioga, Capa, Grenora.
Total	25,181	24,957	

[1] Based on North Dakota Geological Survey county data adjusted to Bureau of Mines total.
[2] Preliminary figures.

TABLE 7.—Wildcat- and development-well completions in 1963, by counties

County	Oil	Dry	Total	Footage
Wildcat:				
Adams		1	1	2,400
Billings	1		1	13,800
Bottineau	2	14	16	69,200
Burke	1	11	12	79,300
Divide		4	4	29,000
Mountrail		2	2	17,000
McHenry		3	3	12,900
Renville	2	17	19	90,400
Slope		1	1	9,400
Ward		1	1	6,200
Williams		3	3	27,200
Total	6	57	63	356,800
Development:				
Billings	2	1	3	36,100
Bottineau	17	17	34	125,900
Bowman	12	2	14	119,000
Burke	26	14	40	252,900
McHenry	2		2	8,400
McKenzie	6	1	7	77,700
Renville	6	4	10	45,900
Ward	1		1	7,100
Williams	6	2	8	63,100
Total	78	41	119	736,100
Total all drilling	84	98	182	1,092,900

Source: Oil and Gas Journal.

The Portal pipeline, from fields on the Nesson anticline in Bottineau, Burke, and Renville Counties to its junction with the Interprovincial and Minnesota pipeline at Clearbrook, Minn., operated the entire year. Throughput was approximately 20,000 barrels a day. About one-

third of the oil was delivered to Superior, Wis., and a small quantity to the refinery at Wrenshall, Minn., through the Interprovincial pipeline. The remainder was delivered to the Great Northern Refining Co. at Pine Bend, Minn., and to the Northwestern Refining Co. at St. Paul Park, Minn., through the Minnesota pipeline. Gathering lines were completed to the South Westhope and Black Slough fields in Bottineau and Burke Counties.

NONMETALS

The value of nonmetal commodities produced in 1963 was $10.2 million, representing 10.8 percent of the value of all mineral production in the State and a substantial gain over the value recorded in 1962. Substantial gains in values of output were noted for sand and gravel and stone, with minor declines in the values of clays and salt production.

Clays.—Fire and miscellaneous clays were produced in four counties. The miscellaneous clay, including shale, was used largely in manufacturing lightweight aggregate, and the fire clay for building brick, sewer tile, and other heavy clay products. A small quantity of bentonite was produced for manufacturing prepared mortar.

Gem Stones.—Agate, chalcedony, jasper, petrified wood, and other gem stones and mineral specimens were collected in Billings, Kidder, Stark, and other counties.

Salt.—Salt production by solution mining from the Charles formation through 8,500-foot wells in Williams County was 18 percent above that of 1962. The salt was used principally for stock and other feeds, oil-well drilling, and water softening. Shipments were made to the Pacific Northwest, upper Midwest, and Canada.

Sand and Gravel.—Output of sand and gravel declined 1 percent compared with that of 1962; however, the value increased 29 percent, reflecting the greater degree of preparation and rigid material standards required in constructing Federal-aid highways.

Of the 9.5 million tons produced, 6.7 million tons, 71 percent, was by Government crews and contractors; the remaining 2.8 million tons, 29 percent, was by commercial operators. Utilization of the output was 7.8 million tons (82 percent) for road construction and paving, 0.9 million tons (10 percent) for building, 0.6 million tons (6 percent) for fill, and the remainder for railroad ballast and other uses. Production by Government crews and contractors—16 percent and 84 percent, respectively—was used almost entirely for road construction; a very small part was used for building. Because of rigid specifications for sand and gravel used in road construction, more of the output was washed, screened, or otherwise prepared at 23 stationary plants and at 293 locations using portable plants which ranged in output from less than 25,000 to 500,000 tons per year. Production was at 331 operations: 54 by commercial operators, 35 by Government crews, and 242 by Government contractors.

Prices ranged from $1.41 per ton for building gravel to $0.39 for railroad ballast. The average value of all sand and gravel produced was $0.96 per ton.

TABLE 8.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	399	$469	411	$492
Paving	17	20	194	217
Fill	(1)	(1)	75	57
Other	37	30		
Industrial: Blast			(2)	(2)
Total	453	519	680	766
Gravel:				
Construction:				
Building	446	808	414	630
Paving	1,156	662	928	1,038
Railroad ballast	117	46	221	85
Fill	381	164	477	465
Other	11	6		
Miscellaneous	29	19	49	52
Total	2,140	1,705	2,089	2,270
Total sand and gravel	2,593	2,224	2,769	3,036
Government-and-contractor operations:				
Sand:				
Building	100	50		
Paving	346	336	2,082	1,908
Total	446	386	2,082	1,908
Gravel:				
Building	192	264	87	77
Paving	4,905	3,980	4,591	4,172
Fill	1,479	268		
Total	6,576	4,512	4,678	4,249
Total sand and gravel	7,022	4,898	6,760	6,157
All operations:				
Sand	899	905	2,762	2,674
Gravel	8,716	6,217	6,767	6,519
Total	9,615	7,122	9,529	9,193

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Figure withheld to avoid disclosing individual company confidential data; included with construction sand used as "fill."

Stone.—Output of crushed stone—used for riprap, as a concrete aggregate, and for road construction—increased sixfold over that of 1962. Over one-half of the production was by contractors for the North Dakota State Highway Department; the material was used in constructing Federal-aid and State highways.

The production of sand and gravel and stone reflected the rate of construction of the Federal and State highway system. Construction of the National System of Interstate and Defense Highways continued. According to a report [3] by the Bureau of Public Roads, 52.9 miles of the system was completed to full standards, including 14.1 miles that previously had been completed to standards adequate for current traffic. At yearend 25.3 miles was completed to standards

[3] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 3, 1963. Press Release BPR 64–9, Feb. 7, 1964.

adequate for current traffic. Of the total designated mileage of the system in the State, 267.0 miles was open to traffic and 51.6 miles was under construction; engineering and acquisition of right-of-way was in progress on 123.2 miles, leaving 126.9 miles to be programed. Major construction during the year was on U.S. Interstate Highway 94, west of Bismarck, and U.S. Interstate Highway 29, north of Grand Forks. Under the Federal-aid program for primary, secondary, and urban highways, 542.2 miles was completed.

Sulfur.—Elemental sulfur was recovered at the natural gas processing plants at Lignite in Burke County and at Tioga in Williams County. Because of the difficulty in determining the country of origin of some byproduct sulfur recovered at natural gas plants and petroleum refineries, particularly on the eastern seaboard and Gulf ports, the quantity and value of sulfur recovered from natural gas plants and petroleum refineries were not included in the mineral production statistics of those States where it was recovered.

Vermiculite.—Crude vermiculite from deposits in Montana was exfoliated at a plant in Ward County. The processed product was used for insulation, as a lightweight aggregate, and as a soil conditioner.

METALS

Uranium Ore.—The quantity of uranium oxide contained in ash derived from uraniferous lignite was substantially greater than in 1962. Four operators, three in Billings County and one in Slope, shipped lignite ash, which contained an average of 0.30 percent of uranium oxide to plants in New Mexico, South Dakota, and Wyoming for extraction of uranium. At some locations the lignite beds were stripped of overburden, and the lignite was ignited with propane torches and compressed air. The lignite burned in 30 to 60 days, depending upon the thickness. Elsewhere, the lignite was transferred to central processing plants consisting of rotary kilns to burn the lignite; one company constructed a portable burning plant that was moved to various mine sites. Negotiations for establishing a uranium processing plant to recover uranium directly from the lignites were terminated because no acceptable proposal had been offered.

The lignite also contained a small quantity of molybdenum. Mills, where the ash was processed, were being prepared to extract the molybdenum to avoid excessive contamination of the uranium oxide sold to the U.S. Atomic Energy Commission. Mines Development, Inc., operating the uranium processing plant at Edgemont, S. Dak., recovered 1.6 tons of molybdenum concentrate containing 1,249 pounds of molybdenum from ash of North Dakota origin. None of the concentrate was shipped, and the value was not included as mineral production in 1963.

REVIEW BY COUNTIES

Counties with significant production or outstanding developments in the mineral industries are discussed in this section.

Billings.—Crude oil production, from six pools in four fields, was slightly above that of 1962; the county continued to be ranked eighth

in the State in output. Of the four wells completed during the year, one was a new discovery and two were successful development wells. Amerada Petroleum Corp. deepened its No. 8 Scoria unit from the Madison limestone to the Precambrian. Total depth of the well was 13,703 feet. The well flowed 91 barrels of oil per day, with 17 percent water, from the Madison limestone at 9,120 to 9,140 feet, and 101 barrels of oil per day, with 14 barrels of water, from the Red River (Ordovician) formation at 12,070 to 12,086 feet. This was the first production of oil from Ordovician formations in the south-central part of the Williston basin. Nearest previous production from the Red River formation was from the abandoned Wibaux field in Montana, 36 miles to the west, and at the Cedar Creek field in Bowman County, 60 miles to the southwest. The discovery also marked the third producing horizon in the Scoria field; production had been from the Madison limestone and the shallower Heath (Pennsylvanian) sandstone.

The county was ranked first in the State in output of uranium derived from uraniferous lignites. Geo-Resources Exploration, Inc., which operated a strip mine 15 miles south of Belfield, burned the material in a kiln near Belfield. The resulting ash was shipped to the Edgemont, S. Dak., processing plant for recovery of the contained uranium. Manidon Mining Co., with leases 20 miles south of Belfield, burned the lignite in place and shipped the ash to the Edgemont plant. Susquehanna-Western, Inc., parent company of Mines Development, Inc., owner of the processing plant at Edgemont, acquired the Manidon Mining Co. properties and operated them in conjunction with other holdings. Union Carbide Nuclear Co. Division, Union Carbide Corp., also mined and burned lignite and shipped the ash to its processing plant at Rifle, Colo. The company began building a large rotary-kiln burning plant near Belfield; operations were expected to start early in 1964.

Bottineau.—Bottineau County was ranked fourth in the State in crude petroleum production. Output, from 20 pools in 19 fields, slightly below that of 1962, was principally from the Newburg, South Westhope, Wiley, and Haas fields. Sixteen exploration wells were completed, of which 2 were discoveries; of 34 development wells completed—in the Roth, Wiley, and Newburg fields—17 were successful.

Vaughan Petroleum Co. completed its No. 1 Karl Kersten at the Russell field, 2.5 miles south of the Newburg field in the Mission Canyon formation. The well pumped 50 barrels of oil per day, with 24 percent water, from the Charles formation at 3,397 to 3,403 feet. Total depth of the well was 3,701 feet. Offset wells to the northwest and southeast were failures.

Two miles south of the Scandia field, the No. 1 Kjelshus well was completed by I. J. Wilhite at a total depth of 3,142 feet. Initial production was 65 barrels of oil and 9 barrels of water on pump from the Mission Canyon formation at 3,118 to 3,125 feet. An offset well to the southwest was a failure.

Two and one-half miles southwest of the Haas field, Quintana Petroleum Co. completed the No. 1 Nelson well at 4,825 feet. Initial production was 100 barrels of oil per day, on pump, from the Mission Canyon formation at 4,143 to 4,152 feet. Offset wells to the southwest and southeast were being drilled at yearend. An extension well south-

TABLE 9.—Value of mineral production in North Dakota, by counties[1]

County	1962	1963[2]	Minerals produced in 1963 in order of value
Adams	$54,717	$109,713	Coal, sand and gravel, clays.
Barnes	215,300	245,901	Sand and gravel, stone.
Benson	65,300	84,000	Sand and gravel.
Billings	1,817,069	1,937,628	Petroleum, uranium ore, natural gas, gem stones.
Bottineau	7,439,600	6,830,000	Petroleum, sand and gravel, natural gas, peat.
Bowman	2,844,203	3,303,794	Petroleum, coal, natural gas, sand and gravel.
Burke	[3] 13,445,764	12,925,632	Petroleum, natural gas, LP gases, coal, natural gasoline, sand and gravel.
Burleigh	537,537	619,370	Sand and gravel, coal.
Cass	(4)	278,542	Sand and gravel, stone.
Cavalier	99,500	8,000	Sand and gravel.
Dickey	44,300	109,562	Sand and gravel, stone.
Divide	1,745,114	1,791,895	Petroleum, coal, sand and gravel, natural gas, LP gases, clays, natural gasoline.
Dunn	161,360	146,844	Petroleum, sand and gravel, coal, natural gas.
Eddy	(4)	344,000	Sand and gravel.
Emmons	30,200	15,000	Do.
Foster	23,900	31,442	Sand and gravel, stone.
Grand Forks	325,700	679,000	Sand and gravel.
Grant	77,893	62,789	Coal, sand and gravel.
Griggs	5,400	128,464	Sand and gravel, stone.
Hettinger	77,146	178,200	Sand and gravel, coal.
Kidder	2,500	200	Gem stones.
La Moure	54,200	5,000	Sand and gravel.
Logan		44,000	Do.
McHenry	561,530	424,000	Sand and gravel, petroleum, natural gas.
McIntosh	38,600	66,000	Sand and gravel.
McKenzie	[3] 19,835,000	20,429,303	Petroleum, natural gas, LP gases, natural gasoline, sand and gravel, stone.
McLean	329,441	369,941	Coal, sand and gravel.
Mercer	2,293,909	(4)	Do.
Morton	547,370	631,376	Sand and gravel, clays, coal.
Mountrail	4,338,590	4,270,000	Petroleum, natural gas, sand and gravel.
Nelson	53,600	34,000	Sand and gravel.
Oliver	28,982	25,058	Coal, sand and gravel.
Pembina	9,200	48,000	Sand and gravel.
Pierce	(4)	75,000	Do.
Ramsey	33,600	44,000	Do.
Ransom	22,400	(4)	Sand and gravel, stone.
Renville	5,459,400	5,126,000	Petroleum, sand and gravel, natural gas.
Richland	121,500	254,219	Sand and gravel, stone.
Rolette	54,400	122,000	Sand and gravel.
Sargent	59,200	169,000	Do.
Sheridan	29,200	215,000	Do.
Sioux	(4)	(4)	Stone.
Slope	9,100	(4)	Uranium ore.
Stark	489,367	470,912	Sand and gravel, coal, petroleum, clays, natural gas, gem stones.
Steele	19,600	218,000	Sand and gravel.
Stutsman	285,000	348,000	Do.
Towner	(4)	(4)	Sand and gravel, stone.
Traill	153,000	238,000	Sand and gravel.
Walsh	446,900	711,000	Do.
Ward	2,014,993	2,133,397	Sand and gravel, coal, petroleum.
Wells	135,500	117,047	Sand and gravel, stone.
Williams	[3] 22,301,997	23,202,307	Petroleum, natural gas, LP gases, salt, natural gasoline, sand and gravel, coal, stone.
Undistributed[5]	[3] 1,881,064	4,883,227	
Total	[3] 90,619,000	94,504,000	

[1] Golden Valley is not listed, because no production was reported.
[2] Petroleum value is preliminary.
[3] Revised figure.
[4] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[5] Includes some sand and gravel (1962) and gem stones that cannot be assigned to specific counties, and values indicated by footnote 4.

west of the Starbuck field, completed by Cardinal Petroleum Co., pumped 82 barrels of oil a day from the Spearfish formation.

Sand and gravel was produced by Government crews and contractors for the State highway department and by contractors for the U.S. Army Corps of Engineers.

Peat from bog deposits in the Turtle Mountains was mined and dried for use as a soil conditioner.

Bowman.—Output of coal (lignite) from the Peerless strip mine operated by Knife River Coal Mining Co. was 14 percent below that of 1962. Crude oil production from Ordovician formations in the Cedar Creek field was 12 percent above that of 1962. Dry natural gas was produced from the Eagle sandstone in the Cedar Creek and Little Missouri fields. Although no exploratory drilling was conducted in the county during the year, development drilling at the Cedar Creek field was the largest single-field program in the State. Of 14 development wells completed, 12 were successful, 11 at the Cedar Creek field. Sand and gravel was produced by contractors for the State highway department.

Burke.—Crude petroleum output from 20 fields—primarily from the Rival, North Tioga, Black Slough, Portal, and Lignite fields—was 7 percent below that of 1962. Completion of 12 exploratory wells resulted in 1 discovery. United States Smelting Refining & Mining Co. completed the No. 1 Radenz well in the Perella field at a total depth of 5,635 feet. The well flowed 166 barrels of oil per day from the Madison limestone (Midale-Rival) at 5,506 to 5,516 and at 5,526 feet. The field was 5 miles north of the nearest production in the Madison limestone at the Bowbells field. No development drilling at the field was attempted during the year. Elsewhere, development drilling at the Black Slough, Portal, Flaxton, and Rennie Lake fields resulted in 26 producing wells from 40 completions.

Oil-well gas from fields in Burke and Divide Counties was processed at the Texaco Inc. natural gas plant at Lignite. Natural gasoline, butane, propane, and elemental sulfur were recovered. Residual gas was marketed through pipelines of the Montana-Dakota Utilities Co. Sulfur recovery was 40 percent above that of 1962.

Production of coal (lignite) from the Bonsness strip mine and the Kincaid strip mine operated by Truax-Traer Coal Co. Division, Consolidation Coal Co., Inc., was 71 percent below that of 1962. Sandberg Sand and Gravel Co. at Lignite produced building sand and gravel; contractors produced paving sand and gravel for the State and county highway departments.

Burleigh.—The county was ranked fifth in the State in the output of sand and gravel. Dakota Sand & Gravel Co. and Northern Improvement Co., both of Bismarck, produced building and miscellaneous gravel. Government crews and contractors produced paving sand and gravel for the State highway department for use in constructing Interstate Highway 94 in the vicinity of Bismarck. Coal output from the Ecklund strip mine, operated by Ecklund-Taplin Coal Co., was 7 percent below that of 1962.

Cass.—The county was ranked 8th in the State in the production of crushed stone and 10th in the production of sand and gravel. Output was entirely by contractors for the State highway department for use in constructing Interstate Highways 29 and 94 and other Federal-aid highways.

Divide.—The county was ranked second in the production of clays, fourth in the production of coal, and ninth in the production of petroleum. Miscellaneous clay produced by Baukol-Noonan, Inc., was

used in manufacturing lightweight aggregates at its plant at Noonan. Lignite output, entirely by Baukol-Noonan, Inc., at its Baukol-Noonan strip mine, was slightly more than that of 1962. Operations were moved to a new mine site 5 miles east of the original Baukol-Noonan pit and near Larson. Reserves at the Larson mine were estimated at 20 million tons of lignite under an average 35-foot overburden. The old mine site, just east of Noonan, was operated for 34 years and total production was 6 million tons. Development of the new site was necessary because of depletion of readily recoverable lignite. A $500,000 tipple with an hourly capacity of 400 tons was constructed at the Larson site. The total cost of the move was nearly $750,000. Petroleum production from five fields, largely from the North Tioga and Stoneview fields, was slightly below that of 1962. All four exploratory wells completed were failures. There was no development drilling during the year. Contractors produced paving sand and gravel for the State highway department for road construction; the county highway department produced paving gravel for road repairs and maintenance.

Dunn.—Petroleum production from the one-well Lost Bridge field declined 30 percent compared with that of 1962. No exploratory or development drilling was conducted in the county during the year. Government crews and contractors produced paving sand and gravel for the State highway department.

Grand Forks.—The county was ranked third in the State in the production of sand and gravel. Bradshaw Gravel Supply, Davidson Gravel Supply, and John Klevin produced building, paving, and fill sand and gravel. Government crews and contractors produced paving sand and gravel for the State highway department, the city of Grand Forks, and the U.S. Army Corps of Engineers. Much of the material was used in constructing the north-south Interstate Highway 29 through Grand Forks. A contract was awarded for constructing the last-scheduled Minuteman base: A 150-missile complex at Grand Forks.

McHenry.—Petroleum production from the Pratt field was nearly four times greater than in 1962. Three exploratory wells were failures; two development wells completed were producers. The county was ranked ninth in the State in the output of sand and gravel. Government crews and contractors produced paving sand and gravel for the State highway department and the U.S. Army Corps of Engineers. Hallet Construction Co. produced building sand and gravel and paving gravel, and the Great Northern Railway Co. produced ballast gravel.

McKenzie.—The county was ranked second in the State in crude petroleum production and third in the State in output of crushed stone. Petroleum production from 20 pools at 12 fields, mostly from the Antelope, Blue Butte, Charlson, and Clear Creek fields, was 2 percent above that of 1962. No exploratory wells were drilled. Of seven development wells completed, six were producers. Contractors produced crushed stone and paving sand and gravel for the State highway department for State highway construction. The McKenzie County Highway Department produced paving gravel for repairs and maintenance of the county highway system.

Mercer.—The county continued to lead the State in the production of coal (lignite). Output, slightly above that of 1962, represented 43 percent of the total coal production in 1963, compared with 38 percent in 1962.

Knife River Coal Mining Co. operated its Beulah strip mine and continued development of the new South Unit strip mine south of Beulah. The annual capacity of the new South Unit and the older North Unit was expected to reach 1.2 million tons as additional facilities were installed. The increased capacity was necessary to provide fuel for the new 66-megawatt unit at the R.M. Heskett generating plant at Mandan and another at Fergus Falls, Minn. Truax-Traer Coal Co. operated the Dakota Star strip mine, and North American Coal Corp. operated the Indian Head strip mine.

Missouri River Sand & Gravel produced building and paving sand and building and miscellaneous gravel. Contractors produced paving sand and gravel for the State highway department.

Morton.—The county was ranked 1st in clay production, 4th in sand and gravel, and 10th in coal (lignite). Hebron Brick Co. produced miscellaneous clay for manufacturing building brick and also produced bentonite for use in manufacturing prepared mortar. Baukol-Noonan, Inc., produced miscellaneous clay for manufacturing lightweight aggregates. Building and paving sand and gravel were produced by Helm Brothers, Inc., Mandan Transfer & Storage, Inc., F. C. Kist, and Ulrich Schleicher, all of Mandan. Helm Brothers, Inc., also produced miscellaneous gravel, and Mandan Transfer & Storage, Inc., produced fill gravel. Paving sand and gravel was produced by contractors for the State highway department and the city of Mandan. Government crews produced paving gravel for the State and county highway departments. Output by and for the State highway department was for use in constructing Interstate Highway 94 in the vicinity of Mandan.

The Standard Oil Co. (Indiana) operated its 44,000-barrel-per-day refinery at Mandan throughout the year. Throughput was 15.1 million barrels, a 1-percent decline compared with that of 1962.

Mountrail.—Although petroleum production from the Tioga, White Earth, and East Tioga fields was 4 percent below that of 1962, the county continued to be ranked sixth in the State in petroleum output. Two exploratory wells completed were failures; no development drilling was carried on during the year. Tioga Sand and Gravel produced building sand and building and paving gravel. Government crews and contractors produced paving sand and gravel for the State highway department.

Renville.—Crude petroleum production from five fields, mainly from the Glenburn and Sherwood, was 7 percent below that of 1962. The county was ranked fifth in the State in crude oil output. Two of 19 exploratory wells completed were discoveries. Cardinal Petroleum Co. and F. M. Ricks completed the No. 1 Ostlund well at a total depth of 5,230 feet in the Mission Canyon formation. Initial production was 75 barrels of oil per day with 9 barrels of water, on pump, from the Mission Canyon formation at 5,215 to 5,220 feet. The discovery, named the Tolley field, was 14.5 miles southwest of the nearest production from the Madison limestone at the Sherwood field. A con-

firmation well ½ mile to the southwest flowed 20 barrels of oil per hour from the Madison limestone. A confirmation well ½ mile to the southeast was abandoned, and another well 1 mile west of the discovery was being drilled at the end of the year. Texota Oil Co. completed the No. 1 Preskey well, for the second discovery in the county. Total depth of the well was 4,750 feet, and initial production was 108 barrels of oil per day with 3 percent water, from the Mission Canyon formation at 4,590 to 4,592 feet. No additional drilling was done to confirm the discovery. Six of ten development wells completed were producers. Of considerable significance was the No. 1 Grenges-Slate well, which extended the Sherwood field 1 mile to the east. The well flowed 286 barrels of oil per day from the Madison limestone at 4,136 to 4,142 feet. Another well, 1 mile south of the Sherwood field, was unsuccessful.

Mohall Excavating Service produced building sand and gravel and fill gravel. Contractors produced paving sand for the city of Sherwood and paving gravel for the State highway department and the U.S. Army Corps of Engineers.

Slope.—This was the first year of uranium production from lignite ash from Slope County. Uranco Mining and Exploration Co. shipped lignite ash to the processing plant at Edgemont, S. Dak., for recovery of the contained uranium.

Stark.—Coal (lignite) produced at strip mines by Dickinson Coal Mining Co., Shultz & Lindsay Construction Co., and Walters Coal Mine was 26 percent below that of 1962. Production of crude petroleum from the Dickinson field was 21 percent below that of 1962. No exploratory or development wells were drilled during the year. Fisher Sand & Gravel Co. produced sand and gravel for building, paving, and fill. Contractors produced paving sand and gravel for the State highway department. Dic-Kota Clay Products Co. produced fire clay for manufacturing vitrified sewer pipe.

Walsh.—The county was ranked second in the State in the production of sand and gravel—fourth in 1962. Contractors produced paving sand and gravel for the State highway department and paving gravel for the county highway department. County crews produced paving gravel.

Ward.—The county led the State in producing sand and gravel and was ranked second in the output of coal (lignite). Minot Sand & Gravel Co., Atlas Sand & Gravel, Inc., and Shriock Construction, Inc., produced building, paving, and fill sand and gravel. Soo Line Railroad Co. produced ballast gravel; Great Northern Railway Co. produced fill gravel. Minot Sand & Gravel Co. produced small quantities of blast sand and railroad ballast. Government crews and contractors produced paving sand and gravel for the State and county highway departments. Contractors produced paving gravel for the U.S. Army Corps of Engineers. The 150-missile complex at the Minot Air Force Base was completed. Sand and gravel for the State highway department was for construction on the junction of Federal Highways 2 and 52 at Minot.

Coal (lignite) production from Truax-Traer Coal Co., at the Velva strip mine; Sawyer Fuels, Inc., at the Miller strip mine; and Valley Coal Co., at the Valley strip mine, was cumulatively 24 percent below

that of 1962. Crude-oil production was resumed at the Southwest Aurelia field. No production had been recorded from the field for several years. One new producing well was added to the field. The one exploratory well completed was not successful. Crude vermiculite, from deposits in Montana, was exfoliated by Robinson Insulation Co. at its plant at Minot. The processed material was used for insulation, as a lightweight aggregate, and for soil conditioning.

Williams.—The value of mineral output represented 25 percent of the total value in the State; the county continued to lead the State in the production of crude petroleum. Petroleum production from 15 pools in 10 fields—largely from the Beaver Lodge, Tioga, Capa, and Grenora—was 2 percent above that of 1962. Three exploratory wells drilled during the year were unsuccessful. Of eight development wells completed, six were producers. Natural gasoline, butane, and propane were recovered at the Signal Oil & Gas Co. natural gas plant at Tioga and at the plant at McGregor operated by the Hunt Oil Co. The natural gasoline was used as a blending stock at the refinery at Mandan, and the butane and propane were stored in an underground facility at Mentor, Minn., and at Williston in caverns created by solution salt mining. Residual gas was marketed through pipelines of the Montana-Dakota Utilities Co. Output of elemental sulfur, also recovered at the plant, was 10 percent above that of 1962. Oil-well gas was delivered to the plant at Tioga through an extensive gathering system from fields along the Nesson anticline in Burke, McKenzie, and Williams Counties. Oil-well gas for the plant at McGregor was from the North Tioga and North Tioga Extension fields at Burke and Divide Counties. Westland Oil Co. operated its 2,500-barrel-per-day refinery at Williston. Throughput was 11 percent below that of 1962.

Dakota Salt & Chemical Co. produced salt by solution mining of beds in the Charles formation through 8,500-foot wells. Output was 18 percent above that of 1962.

Coal (lignite) production by Ben L. Nelson & Jacob Senti, at the Black Diamond mine, the only underground coal mine in the State, was 9 percent below that of 1962.

George Mockel, Borsheim Builders Supply Co., and Dale Shubert produced building, paving, and fill sand and gravel. Contractors produced paving sand and gravel for the State and county highway departments. Crushed stone produced by contractors for the State highway department was used for highway construction.

The Mineral Industry of Ohio

By Joseph Krickich [1]

MINERAL production in Ohio reached a record high as value exceeded $400 million for the first time, a 6 percent increase over that of 1962 and $22 million greater than the previous high year 1959. Increased production and value for most of the State's mineral commodities was reported. In response to increased demand by the construction and iron and steel industries, more coal, construction material (cement, stone, sand and gravel), refractory material (fire clay, lime, sandstone, quartzite), and metallurgical fluxing stone (limestone) were produced. Record high levels of salt and lime production and value were established. Nationally, the State continued to lead in clay, lime, and ferroalloy production and was an important producer of coal, salt, and iron and steel.

A constant-dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant-dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 1.—Mineral production in Ohio [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—376-pound barrels	15,352,969	$51,006	16,217,528	$53,244
Masonry—280-pound barrels	945,912	2,793	1,022,559	3,084
Clays—thousand short tons	4,751	12,979	4,841	13,959
Coal (bituminous)—do	34,125	127,051	36,790	136,113
Gem stones	(2)	3	(2)	3
Lime—thousand short tons	3,102	43,792	3,207	45,957
Natural gas—million cubic feet	36,747	9,407	36,817	8,909
Peat—short tons	[3] 7,383	106	6,910	109
Petroleum (crude)—thousand 42-gallon barrels	5,835	18,089	[4] 6,171	[4] 19,439
Salt—thousand short tons	4,187	28,706	4,245	29,682
Sand and gravel—do	35,204	43,333	37,790	44,368
Stone—do	34,470	57,202	37,537	62,787
Value of items that cannot be disclosed: abrasive stones and gypsum	----	1,588	----	1,742
Total	----	[3] 396,055	----	419,396

[1] Production as measured by mine shipment, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Revised figure.
[4] Preliminary figure.

[1] Minerals specialist, Bureau of Mines, Pittsburgh, Pa.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$310,111	1958	$347,369
1953	310,839	1959	397,520
1954	310,591	1960	396,829
1955	348,096	1961	391,233
1956	380,676	1962	409,212
1957	381,064	1963	433,353

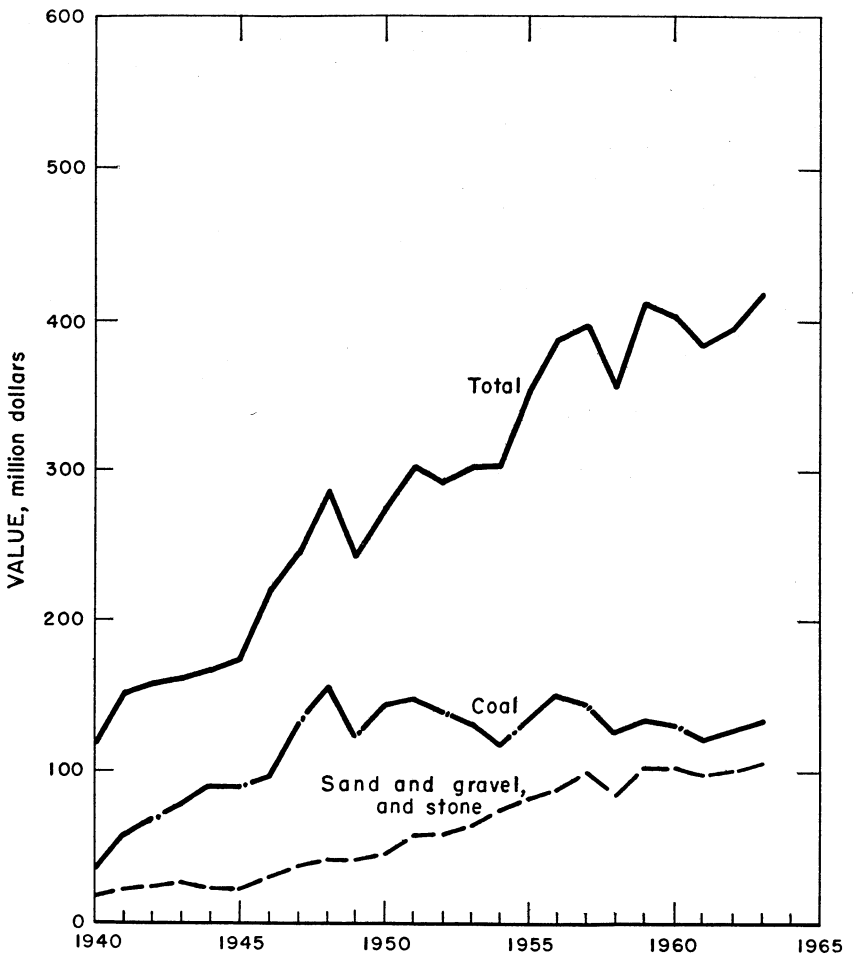


FIGURE 1.—Value of coal, sand and gravel, and stone, and total value of mineral production in Ohio, 1940–63.

Water.—A national survey of the 1962 water requirements and usage by the mineral industries was made in 1963 by the Bureau of Mines. Study of the data will aid in determining future needs of the industry and in planning water developments. Ohio mineral industries, including petroleum and natural gas, used over 52.9 billion gallons of water.

As indicated by table 3, sand and gravel processing demanded more than one-half the total usage. The remainder was used in other nonmetallic mining and mill operations, including clay, salt, and gypsum, in quarries and stone mills and in coal beneficiation. Water used for the secondary recovery of oil and natural gas and well-drilling operations totaled 412 million gallons—less than 1 percent of the State's total requirements. Most of this water was used in the secondary recovery of oil and natural gas; less than 8 percent was used in well-drilling operations. Most of the wells were drilled with cable tools requiring 10.9 gallons of water per foot; less than 20 percent of the wells were drilled with rotary equipment. Rotary drilling used only an average of 5.5 gallons of water per foot drilled. Most of the rotary drilling was by air rotary and accounts for the low-water use. Forty-one percent of the water used for secondary recovery of oil and gas and 99 percent used in well drilling was fresh; the remainder in each case was saline.

TABLE 3.—Water use by the mineral industry of Ohio, 1962

(Million gallons)

Type of operation	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	2,498	404	2,902	2,317	182	43.38
Coal-Bituminous	645	7,091	7,736	355	290	10.38
Nonmetal mines and mills	3,934	7,087	11,021	1,315	2,618	92.31
Sand and gravel plants	25,624	5,225	30,849	24,795	829	591.33
Total	32,701	19,807	52,508	28,782	3,919	158.96

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Stones.—Grindstones were produced in Lorain and Washington Counties. Production in Lorain County was as a coproduct of sandstone quarrying. Production and value was below that of 1962.

Cement.—Production and shipments of portland and masonry cements increased and were the highest since 1960. The average value per barrel of portland cement declined from $3.32 in 1962 to $3.28; average value per barrel for masonry cement increased by $0.07 to $3.02. Plants operated at 73 percent of capacity compared with 69 percent in 1962. Yearend stocks at mills were 41,000 barrels higher than at the end of 1962. Ten plants in eight counties were active. The leading cement-producing counties, in decreasing order based on total value of sales, were Greene, Muskingum, and Lawrence.

Tonnages of cement raw materials used by producing companies were, limestone and cement rock, 4.4 million; clay and shale, 680,000; gypsum, 136,000; sand and sandstone, 81,000; and iron materials, 19,000. Other materials used included fluorspar, lime, alumina, slag, grinding aids, and air-entraining compounds. Companies produced mostly types I–II (general use) and type III (high-early-strength). A limited quantity of waterproof cement was produced.

Shipments of portland cement were to consumers in Ohio (68 percent), Indiana (10 percent), Michigan (9 percent), and West Virginia (7 percent). The remainder, in decreasing order, went to Kentucky, Pennsylvania, Virginia, Maryland, New York, and Illinois. Most of the masonry cement was consumed in Ohio, Indiana, and West Virginia. Distribution of portland cement shipments by types of customers was as follows: Ready-mixed concrete companies, 9.8 million barrels; highway and other contractors, 2.5 million barrels; concrete product manufacturers, 2.4 million barrels; and building material dealers, 1.5 million barrels. The remainder went to Federal, State, and local governmental agencies and miscellaneous customers. Shipments of portland cement by truck totaled 13.9 million barrels; rail shipments were 2.3 million barrels. Small quantities were used by the producers. Bulk shipments totaled 14.9 million barrels. The remainder was shipped in containers, mainly paper bags.

Annual finished cement capacity remained at 22.4 million barrels with 69 percent wet processed and 31 percent dry processed. Producers used 396.8 million kilowatt-hours of electrical energy of which 34 percent was generated by the producers and 66 percent was purchased from public utility companies.

TABLE 4.—Finished portland cement produced, shipped, and in stock

(Thousand barrels and thousand dollars)

Year	Number of active plants	Production	Shipments from mills		Stocks at mills Dec. 31
			Quantity	Value	
1954-58 (average)	10	14,895	14,525	$44,224	1,441
1959	11	18,028	18,141	60,560	1,938
1960	11	16,850	16,752	58,470	1,962
1961	10	15,059	15,303	53,251	1,695
1962	10	15,465	15,353	51,006	[1] 1,857
1963	10	16,300	16,218	53,244	1,898

[1] Stock adjustment.

Clays.—Ohio continued to lead the Nation in clay production. Total output (fire clay and miscellaneous clay and shale) increased 2 percent above that of 1962, mainly because of greater demand for refractory material and clay used for manufacturing cement. Clay output for refractory uses increased by 61,000 tons to 827,000 tons, and clay for cement manufacture rose by 63,000 tons to 683,000 tons. Clays used for heavy clay products continued to decline and totaled 2.9 million tons, 3 percent below that of 1962. Increased output of clay for lightweight aggregate (expanded clay) was reported. As in 1962, 53 percent of the total production was miscellaneous clay or shale; the remainder was fire clay used chiefly in heavy clay products and refrac-

tories. Other uses of Ohio clay included pottery and stoneware, floor and wall tile, filler materials, and rotary drilling mud. Cuyahoga, Stark, and Greene Counties led in output among the 39 counties producing miscellaneous clay. Fire clay was produced in 17 counties. Tuscarawas and Stark Counties led in output.

TABLE 5.—Clays sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Carroll	91,421	$154,249	88,225	$153,414
Columbiana	359,121	(1)	397,001	(1)
Cuyahoga	355,173	269,345	367,512	298,440
Gallia	7,900	12,245	4,792	7,428
Hocking	15,337	46,012	(1)	(1)
Holmes	86,287	185,541	92,315	283,677
Jackson	90,967	(1)	(1)	(1)
Jefferson	140,449	930,398	138,764	961,711
Lawrence	209,564	751,342	165,353	591,195
Mahoning	157,135	(1)	170,827	(1)
Marion	112,940	141,175	129,830	276,000
Muskingum	(1)	79,477	(1)	(1)
Perry	245,936	701,701	194,320	582,762
Putnam	20,371	23,234	21,945	22,400
Scioto	7,130	35,027	(1)	(1)
Seneca	14,000	18,000	17,000	13,000
Stark	649,757	1,838,356	751,307	1,873,746
Summit	134,579	161,347	(1)	(1)
Tuscarawas	834,352	2,544,045	815,646	2,590,769
Van Wert	4,169	6,598	1,400	1,400
Wayne	99,283	89,668	106,408	106,408
Undistributed [2]	1,114,868	4,990,803	1,378,371	6,196,397
Total	4,750,739	12,978,563	4,841,016	13,958,747

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes data from the following counties: Ashland, Athens, Auglaize, Darke, Delaware, Franklin, Greene, Hancock, Harrison, Henry, Highland, Lake, Lucas, Madison (1962), Medina, Noble, Paulding, Portage, Richland, Vinton, Williams, Wood (1963), Wyandot, and data indicated by footnote 1.

Gem Stones.—Gem stones (mineral specimens) were recovered mostly by members of mineral and lapidary clubs. Value remained the same as in 1962. Materials recovered included agate, calcite, celestite, flint, jasper, and marcasite. Collectors were active in Coshocken, Henry, Licking, and Ottawa Counties.

Gypsum.—An increase in production and value of crude gypsum was reported from the two underground mines in Ottawa County. Output was calcined at nearby plants for use in manufacturing building products. Crude gypsum from outside the State also was calcined at a plant in Lorain County. Production of calcined gypsum was 324,000 tons valued at $4.9 million, compared with 296,000 tons and $4.6 million in 1962. Calcining equipment used by producing companies consisted primarily of kettles.

Iron Oxide Pigments.—Minnesota Mining & Manufacturing Co., Copley, Summit County, continued as the State's only producer of red iron oxide pigments. Primary raw material utilized by the company was pyrite cinders recovered as a byproduct of sulfuric acid manufactured in Delaware.

Lime.—Ohio continued to lead in lime production and supplied 22 percent of the national output. Increased demand for refractory and chemical and industrial lime resulted in a record high production level

of 3.2 million tons, 1 percent above the previous record high year 1959. Output of building lime was below that of 1962. Agricultural lime production decrease for the 9th consecutive year. Average unit values for all major commodities continued to increase. Average value per ton increased from $14.12 in 1962 to $14.33. Data reported in table 6 represents only primary lime and excludes regenerated quicklime produced in Montgomery and Ross Counties. Production and value of regenerated quicklime increased above that of 1962. Primary lime output was 86 percent quicklime and 14 percent hydrated lime. Quicklime was used chiefly in chemical and industrial application; hydrated lime was chiefly for construction. The leading lime-producing area was Sandusky County, supplying 31 percent of the total quantity and 35 percent of the total value. The predominant calcining and processing equipment used by reporting companies were shaft kilns and continuous hydrators. Anthracite and bituminous coal, coke, natural gas, producer gas, and carbon monoxide were used as fuels. Shipments of lime were made to consumers in the District of Columbia and all States except Alaska, Arizona, Hawaii, Idaho, and Oregon. Exports were made chiefly to Canada, Venezuela, and Chile, with lesser quantities to Italy and Puerto Rico.

TABLE 6.—Lime sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Year	Agricultural		Building		Chemical and other industrial		Refractory		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	44	$587	543	$8,930	1,004	$9,193	1,160	$17,789	2,751	$36,499
1959	31	427	492	9,249	1,563	17,484	1,104	17,961	3,190	45,121
1960	30	449	426	8,288	1,604	18,516	1,057	17,150	3,117	44,403
1961	27	381	399	7,400	1,615	17,864	1,007	15,621	3,048	41,266
1962	26	396	383	7,257	1,743	20,734	950	15,405	3,102	43,792
1963	24	393	369	7,003	1,820	22,187	994	16,374	3,207	45,957

Perlite (Expanded).—Crude perlite shipped from Colorado, Nevada, and New Mexico was expanded at plants in Cuyahoga and Hamilton Counties. Expanded perlite was sold for use as plaster and concrete aggregate, soil conditioner, insulation, and other industrial purposes.

Salt.—Salt production for the 2d consecutive year exceeded 4 million tons, surpassing the previous record high set in 1962 by 1 percent in tonnage and 3 percent in value. The increase was attributed primarily to greater rock salt production from the underground Cleveland mine of International Salt Co. A slight increase in evaporated salt output was reported; brine production was below that of 1962. Rock salt recovered in Cuyahoga and Lake Counties was sold mostly for controlling icy highways and in chemical applications. Evaporated salt was produced in Meigs, Summit, and Wayne Counties. Most of the output was recovered by vacuum-pan process; some was produced in open pans. Evaporated salt was sold for a wide variety of uses, and some was marketed as pressed blocks. Brine producers in Lake and Summit Counties used their output mainly for manufacturing chlorine and soda ash.

Sand and Gravel.—The State's sand and gravel industry was highlighted by greater demand for structural and paving material, reflecting increased construction activity. Output, including Government-and-contractor operations, was 2.6 million tons above that of 1962. Commercial tonnage increased 6 percent, primarily because of greater demand for construction materials. Commercial sand and gravel used in building and highway construction totaled 31.3 million tons, compared with 29.6 million tons in 1962. Production of industrial sand also increased, totaling 1.1 million tons valued at $4.4 million. Most of the industrial sand was used for molding, glass manufacturing, and furnace construction and repair.

TABLE 7.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	5,775	$6,416	5,820	$6,376
Paving	7,152	7,258	7,685	7,560
Fill	673	531	808	606
Molding	383	1,451	444	1,743
Filtration	21	(1)	23	67
Fire or furnace	151	429	(1)	(1)
Other [2]	745	2,559	844	2,805
Total	14,900	18,644	15,624	19,157
Gravel:				
Building	5,628	6,965	5,556	6,717
Paving	11,045	13,535	12,229	14,467
Railroad ballast	(1)	(1)	38	30
Fill	1,035	677	1,784	939
Other	2,018	2,994	1,581	2,415
Total	19,726	24,171	21,188	24,568
Total sand and gravel	34,626	42,815	36,812	43,725
Government-and-contractor operations:				
Sand:				
Building	(3)	(4)		
Paving	281	223	492	370
Fill	4	1	2	1
Other			24	8
Total	285	224	518	379
Gravel:				
Building	(3)	1		
Paving	285	291	417	249
Fill	(3)	(4)	19	7
Other	8	2	24	8
Total	293	294	460	264
Total sand and gravel	578	518	978	643
All operations:				
Sand	15,185	18,868	16,142	19,536
Gravel	20,019	24,465	21,648	24,832
Grand total	35,204	43,333	37,790	44,368

[1] Figure withheld to avoid disclosing individual company data; included with "other".
[2] Includes the following sands: Glass, grinding and polishing (1962), blast, engine, ferrosilicon (1962), ground, and other; and data indicated by footnote 1.
[3] Less than 500 tons.
[4] Less than $500.

Commercial producers were active in 69 counties, compared with 71 in 1962. Most of the commercial producers had production below 25,000 tons; two operations had outputs exceeding 1 million tons and five operators produced from 500,000 tons to 1 million tons. Commercial producers processed 33.1 million tons of sand and gravel. Shipments to consumers were by truck, 93 percent; rail, 4 percent; and the remainder by water. The leading sand and gravel producing areas were Franklin and Hamilton Counties, each with production exceeding 4 million tons. Other leading areas, each with more than 2 million tons were Montgomery, Portage, Butler, and Stark Counties. These six counties accounted for 48 percent of the total State production.

Slag (Iron-Blast-Furnace).—In contrast to the national output, which increased slightly, Ohio's production of processed iron-blast-furnace slag decreased 1.3 million tons from 1962 and totaled 4.5 million tons. Value declined to $8.8 million, a decrease of $2.5 million. However, Ohio continued to rank second among the 16 slag-processing States and supplied 19 percent of the national output. Screened and air-cooled slag accounted for 78 percent of the total processed slag; the remainder was granulated and lightweight (expanded) slag. The main uses for screened and air-cooled slag were as aggregate for concrete and bituminous construction, highway and airport construction, and as railroad ballast. Slag was processed chiefly at steelmaking facilities near Cleveland, Middletown, and Youngstown.

Stone.—Total stone (limestone, sandstone, and calcareous marl) output increased both in tonnage and value for the 2d consecutive year. The increase was due principally to greater demand for crushed and broken limestone in all major categories except railroad ballast. Greater use of limestone for aggregate accounted for over one-half of the increased output. Limestone production accounted for 98 and 86 percent of the total stone tonnage and value, respectively. Miscellaneous uses of crushed limestone included whiting, filter beds, stone sand, paper and glass manufacture, mineral food, poultry grit, fertilizer filler, and for dust control in coal mines. Production of dimension limestone increased slightly and was used in architectural and construction applications.

Output of dimension and crushed sandstone continued to increase due mainly to greater demand for ganister (refractory). Dimension sandstone was mainly sold as architectural stone; some of the rough and sawed stone was sold for lining steelmaking furnaces. Dimension sandstone also was used in construction and as curbing and flagging. Uses of crushed sandstone included ganister, aggregate, riprap, glass and cement manufacture, and foundry uses.

Limestone operations were reported in 55 counties, with Sandusky, Erie, and Seneca Counties leading in production. Each had outputs exceeding 2 million tons. Sandstone production was reported in 14 counties, compared with 13 in 1962. Scioto County again led in value and Lorain County in tonnage. Values of calcareous marl in Darke County increased, but output was below that of 1962. The material was processed for use as agricultural stone (agstone).

TABLE 8.—Crushed and broken limestone sold or used by producers, by uses

Uses	1962		1963	
	Short tons	Value	Short tons	Value
Riprap	224,614	$282,762	341,524	$494,795
Concrete aggregate and roadstone	17,990,967	23,693,633	19,036,063	24,610,840
Fluxing stone	4,386,457	6,810,896	4,727,532	7,423,231
Agriculture	1,998,599	3,593,383	2,213,197	3,879,888
Railroad ballast	973,786	1,189,968	923,738	1,134,282
Cement	3,677,041	4,754,915	4,083,741	5,847,439
Lime	4,013,831	7,589,217	4,433,031	8,158,754
Miscellaneous uses	635,861	1,845,616	1,112,935	2,454,078
Total	33,901,156	49,760,390	36,871,761	54,003,307

Sulfur (Recovered Elemental).—Elemental sulfur was recovered by catalytic oxidation of hydrogen sulfide by Sun Oil Co. at its Toledo refinery.

Vermiculite (Exfoliated).—Crude material shipped chiefly from Montana and imported from the Republic of South Africa was processed at a plant in Cuyahoga County. Exfoliated vermiculite was sold for plaster aggregate, soil conditioner, loose fill insulation, and other uses.

MINERAL FUELS

Coal (Bituminous).—Bituminous coal production increased 2.7 million tons over that of 1962 and reached the highest level since 1957. However, average value per ton ($3.70) was below the previous year. A total of 447 mines producing 1,000 tons or more were active, 4 fewer than in 1962. The number of active strip mines remained at 266, underground mines dropped from 132 to 119, and auger mines increased from 53 to 62. Sixty-six percent of the total production was strip-mined coal; the remainder came from underground (29 percent) and auger (5 percent) mines.

Output at strip mines totaled 24.4 million tons, nearly 1 million tons greater than in 1962. Production was reported in all 25 coal-producing counties. Harrison, Jefferson, and Morgan Counties, in decreasing order, were the leading areas for strip-mined coal. The average value of strip-mined coal dropped from $3.51 in 1962 to $3.49. Coal was stripped and loaded by 40 electric, 35 diesel electric, 454 diesel, and 67 gasoline shovels or drag lines. Most of this equipment had dipper capacities of less than 3 cubic yards; 4 percent had capacities greater than 12 cubic yards. In addition, 490 bulldozers, 46 carryall scrapers, and 163 power drills were used at strip mines.

Coal from underground mines was recovered in 17 counties; production increased 12 percent and totaled 10.5 million tons. Belmont and Harrison Counties supplied 78 percent of the total underground tonnage. Average value per ton of underground coal dropped from $4.34 to $4.28. Almost the entire underground output was cut by machines (61 percent by cutting machines and 39 percent by continuous mining machines); less than 0.5 percent was cut by hand.

Ninety-five percent of the tonnage was mechanically loaded. Output recovered by continuous mining machines totaled 4.1 million tons, 14 percent greater than that in 1962. The number of continuous mining machines increased from 37 to 41.

Coal recovered by auger mining increased 40 percent and totaled 1,894,000 tons. Average value per ton increased from $3.18 to $3.20. The number of counties reporting production by auger mining remained at 15, but the number of augers in operation increased from 48 to 63. Jefferson, Noble, and Perry Counties, in decreasing order, were the leading areas and supplied 56 percent of the total auger tonnage.

Over 13.4 million tons of coal was cleaned, compared with 13.1 million tons in 1962. The number of active cleaning plants remained at 20. Fifty-five percent of the tonnage cleaned was by jigs. Forty-three percent was by wet-washing other than jigs and the remainder by pneumatic methods. Over 13.3 million tons of coal was crushed (11.4 million tons in 1962), and 4.3 million tons was treated with antifreezing and dust-allaying materials. Shipment to consumers was by rail or water (56 percent), truck (31 percent), and the remainder by other means (mainly pipe line). Output by captive operations totaled 4.7 million tons, 9 percent above that of 1962.

Preliminary employment and injury data for the State's bituminous coal industry indicated that an average of 8,000 men worked 14,980,000 man-hours. Six fatal and 290 nonfatal injuries were reported, compared with 9 fatal and 300 nonfatal in 1962. The rate of 0.16 fatalities per million tons was the lowest in the nation and well below the national average of 0.56.

TABLE 9.—Bituminous coal production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954-58 (average)	35,632	$134,472	1961	32,226	$121,343
1959	35,112	135,729	1962	34,125	127,051
1960	33,957	130,877	1963	36,790	136,113

Coke and Coal Chemicals.—Although production of ovencoke decreased 7 percent, Ohio continued to hold its third ranking position among the 20 producing States. Output totaled 6.3 million tons valued at $111.1 million. Average value per ton, however, increased from $16.57 to $17.52, while the national average decreased by $0.56. Producers carbonized 9.1 million tons of bituminous coal, 7 percent less than in 1962. Coke yield continued its downtrend decreasing from 69.95 percent to 69.76 percent.

Coking coal received at Ohio plants came from West Virginia (48 percent), Pennsylvania (43 percent), Kentucky (7 percent), and Virginia (2 percent). A very limited quantity was shipped from Illinois. Seventy-seven percent of the coal received was high-volatile, 21 percent low-volatile, and 2 percent medium-volatile. Twelve plants (10 furnace and 2 merchant) operating 1,820 slot-type ovens were in existence at yearend. The same number of ovens was reported func-

tional in 1962. Steel companies operated furnace plants primarily at Cleveland, Youngstown, Toledo, and Hamilton; merchant plants were operated at Ironton and Painesville. Eighty-seven percent (85 percent in 1962) of the coke produced was consumed by producing companies, largely in blast furnaces. Commercial sales were to other industrial consumers and for residential heating.

Production of coke breeze decreased slightly to 406,000 tons valued at $2.6 million. Most of the coke breeze was sold, but producing companies used 188,000 tons for steam generation, as a binder and reducing agent in iron ore agglomerating plants, and for other industrial uses. Coproducts recovered included coke-oven gas, 89.5 billion cubic feet; ammonium sulfate, 80,000 tons; and coke-oven tar 81 million gallons. Most of the tar was sold for further refining into tar products; the remainder was used by producers for refining or topping and as fuel. Crude light oil recovered at 10 plants totaled 25.5 million gallons from which 10.2 million gallons of benzene, 2.8 million gallons of toluene, 748,000 gallons of xylene, and 534,000 gallons of solvent naphtha were derived.

Fuel Briquets and Package Fuel.—Consumption of fuel briquets shipped from other States totaled 29,000 tons, 6 percent less than that in 1962. Production and shipments of packaged fuel continued its downward trend as one less plant was active. Shipments totaled 1,068 tons valued at $23,000, 16 percent less than those in 1962. The average value per ton, however, increased from $21.36 to $21.99, but was still below the national average of $23.36. Producers utilized low-volatile bituminous coal for raw material and supplied 8 percent of the total U.S. production. Producers were Ackerman Coal Co., Toledo; Air City Fuels, Inc., Dayton; Pacific Coal & Supply Co., Cleveland; and Ralph Coal & Supply Co., Toledo. Bartak Coal Co., Maple Heights, discontinued operations at the end of 1962.

Peat.—Shipments of peat decreased 6 percent but value was higher than that in 1962. The average per ton value increased from $14.32 to $15.76. The number of active operations dropped to 10 compared with 12 in 1962. Production was reported in six counties. Wyandot County led in value of output. Ohio peat was used mostly for soil improvement purposes. According to a recent survey, known reserves of peat at active operations totaled 211 acres and 464,000 tons. The known reserves throughout the State were 50 million tons.[2]

Petroleum and Natural Gas.—Increased production of petroleum and natural gas was reported but drilling activity declined. A total of 1,111 wells were completed, 99 fewer wells than in 1962. Total footage drilled was 3,033,000 feet averaging 2,730 feet per well, compared with 2,955,000 total footage and 2,442 feet average in 1962. A total of 955 development completions (457 oil, 206 gas, 230 dry, and 62 service) was reported, 155 fewer than in 1962. Development wells were drilled in 43 counties; Washington (112), Morrow (96), Ashland (88), and Portage (84) Counties were the leading areas. Most of the field wells were drilled to depths of 2,500 to 3,750 feet.

Wildcat completions increased to 156 (18 oil, 11 gas, and 127 dry) compared with 100 such completions in 1962. Among the 33 counties

[2] Geological Survey, Coal Resources of the United States (Progress Report) : Circ. 293, Oct. 1, 1953, p. 38.

with exploratory completions, Morrow led with 61 followed by Marion (8) and Knox, Licking, Portage, and Richland, with 7 each. Most of the test wells were drilled between 2,500 and 3,750 feet. Three petroleum and seven dry wells were drilled between 5,000 and 7,500 feet and none went below 7,500 feet.[3] Drilling operations in Ohio were mainly by the cable tool method. The Ohio Division of Geological Survey reported 7,128 oil and 17,016 gas-producing wells in operation on December 31. The number of active oil wells increased by 11 and natural gas wells increased by 149 compared with the number at yearend 1962.

According to the American Petroleum Institute and American Gas Association, proved yearend reserves of petroleum were 87.8 million barrels and for natural gas, 727,912 million cubic feet (14.73 pounds per square inch absolute, at 60° F). Petroleum reserves increased 10.5 million barrels, and natural gas reserves increased by 20,275 million cubic feet. The American Gas Association changed the standard conditions of reporting natural gas reserve estimates from 14.65 pounds per square inch, absolute at 60° F., to 14.73 pounds per square inch, absolute at 60° F. According to a survey, natural gas storage facilities were operated by 3 companies in 15 areas. The companies were East Ohio Gas Co. (4 areas), Manufacturers Light & Heat Co. (1 area), and Ohio Fuel Gas Co. (10 areas). Total capacity of the reservoirs was 371,500 million cubic feet, 3,289 million cubic feet greater than reported in a similar survey in 1961. Of the total capacity, 176.3 billion cubic feet was working gas capacity, and 195.2 billion cubic feet was required as cushion gas.[4]

Total crude oil capacity of active petroleum refineries as of January 1, 1963 was 467,100 barrels per day. Gasoline capacity at active plants remained at 178,000 barrels of which 58 percent was cracking capacity, and the remainder represented reforming capacity. Refineries were operated by Ashland Oil & Refining Co., Canton and Findlay; Pure Oil Co., Newark and Toledo; the Standard Oil Co. (Ohio), Cleveland, Lima, and Toledo; American Bitumuls & Asphalt Co., Cincinnati; Gulf Oil Corp., Cleves and Toledo; Sun Oil Co., Toledo, and Sea-Way Oil Refining Co., Weston.

METALS

Aluminum.—Primary aluminum was produced at Omal near Hannibal by Ormet Corp., jointly owned by Olin-Mathieson Chemical Corp. and Revere Copper & Brass, Inc. Output and value increased above that of 1962. Bauxite imported from Surinam was processed into alumina at the company-owned plant at Burnside, La. The alumina was then shipped by river barge to the Hannibal plant for reduction into aluminum. Annual capacity of the reduction plant remains at 180,000 tons. Olin Mathieson Chemical Corp. completed a multimillion-dollar expansion program at its rolling mills adjacent to the reduction plant. Rolling capacity was increased 50 percent.

Beryllium.—Beryllium metal, alloys, and compounds were produced by the Brush Beryllium Corp. at Elmore. Most of the output was

[3] Oil and Gas Journal. V. 62, No. 4, Jan. 27, 1964.
[4] Bizal, Robert B. Gas Storage Capacity up 2.8 percent. Oil and Gas J., v. 62, No. 18, May 4, 1964, pp. 93–99.

beryllium metal and beryllium-copper alloys. The company acquired ore deposits in Utah from Vitro Corp. of America and the Rochester & Pittsburgh Coal Co. and began studies for the utilization of this material as a commercial source of beryllium.

Ferroalloys.—Ferroalloy shipments totaled 626,000 tons valued at $126.7 million; 16 and 5 percent, respectively, greater than that in 1962. Production increased 13 percent to 617,000 tons. Among the 18 ferroalloy-producing States, Ohio continued to lead in shipments, supplying 30 percent of the national sales. Increased shipments were reported for ferromanganese, silicomanganese, ferrosilicon, ferrovanadium, ferrochromium, and chromium briquets. These were the principal ferroalloys produced. Compared with 1962, lower average unit values for these materials were reported. Production and shipments of silvery pig iron, another important ferroalloy, were below that of 1962. In all, 14 principal classifications of ferroalloys were produced at Ohio plants.

TABLE 10.—Ferroalloy producers in 1963

Company	Location	Type of furnace	Ferroalloys produced [1]
Interlake Iron Corp.	Beverly	Electric	SiMn, FeSi, FeCr.
Do.	Jackson	Blast	Silvery pig iron.
Do.	Toledo	do.	Do.
Jackson Iron & Steel Co.	Beverly	do.	Do.
Ohio Ferro-Alloys Corp.	Brilliant	Electric	FeSi, FeCr.
Do.	Philo	do.	FeMn, SiMn, FeSi, other miscellaneous ferroalloys.
Do.	Powhatan Point	do.	FeSi, Si.
Union Carbide Metals Co.	Marietta	do.	FeMn, SiMn, FeSi, FeCr, spiegeleisen, other miscellaneous ferroalloys.
Do.	Ashtabula	do.	FeMn, SiMn, FeSi.
Vanadium Corporation of America.	Vancoram	do.	FeCr, FeSi.
Do.	Cambridge	do.	FeMn, FeTi, FeV, FeB, FeCb, other miscellaneous ferroalloys

[1] Symbols used: FeMn, ferromanganese; SiMn, silicomanganese; FeSi, ferrosilicon; FeCr ferrochromium FeTi, ferrotitanium; FeB, ferroboron; FeCb, ferrocolumbium; FeV, ferrovanadium; Si, silicon.

Iron and Steel.—According to American Iron and Steel Institute, steel production totaled 18.8 million tons, 1.9 million tons above that of 1962. Nearly 14.8 million tons of the steel was produced in open hearths, and 2.1 million tons in electric furnaces. The remainder was produced in Bessemer converters and basic oxygen furnaces. As in 1962, Ohio ranked second in steel production and accounted for 17 percent of the national output. Pig iron production increased 10 percent above that of 1962 to 12.7 million tons. Shipments increased by 1.3 million tons, totaling 12.8 million tons valued at $738 million. Yearend stocks at furnaces were lower than in 1962. Fifteen plants were active producing basic, Bessemer, malleable, foundry, low-phosphorous, direct-casting, and other pig iron. Two blast furnaces at the Youngstown plant of Youngstown Sheet & Tube Co. were idle. Initial production was started in November at the newly constructed blast furnace at Jones & Laughlin Steel Corp., Cleveland. The Massillon blast furnace of Republic Steel Corp. continued idle. U.S. Steel Corp. at Youngstown abandoned its No. 1 furnace, leaving four furnaces functional. At active plants, 10 of the 43 blast furnaces, were idle the entire year. Over 10.8 million tons of basic pig iron was produced

compared with 9.4 million tons in 1962. Bessemer tonnage was below that of 1962.

Iron ore receipts totaled 9.8 million tons of which 59 percent was domestic ore. Most of the foreign ore received came from Canada and Labrador and the remainder mostly from Venezuela, Chile, Brazil, and Liberia. Over 5 million tons of domestic and 1.9 million tons of foreign iron ore were consumed in blast furnaces. Tonnages of other materials consumed in blast furnaces were sinter (regular), 4.7 million; pellets (regular), 6.9 million; coke and coke breeze, 8.9 million; home and purchased scrap, 967,000; slag scrap, 260,000; limestone and dolomite, 2.9 million; mill cinder and roll scale, 703,000; flue dust, 68,000; and open hearth, basic oxygen, and Bessemer slag 755,000. In addition, domestic and foreign manganiferous ore, pig iron, agglomerated iron ores, and other materials were used in producing pig iron. Agglomerating plants consumed 1.4 million tons of domestic and 1.6 million tons of foreign iron ore and quantities of limestone and dolomite, cinder and scale, slag, and coke breeze. Nearly 4.7 million tons of slag and 159,000 tons of scrap was produced at blast furnaces; 862,000 tons of flue dust was recovered.

Lead and Zinc Pigments.—Willard Storage Battery Co. manufactured black lead oxide pigments at Cleveland. Also at Cleveland, E. I. du Pont de Nemours, & Co., Inc., manufactured zinc chloride pigments. Zinc oxide pigments were manufactured at Columbus by American Zinc Oxide Co.

Titanium.—Titanium sponge was produced by sodium reduction of titanium tetrachloride by U.S. Industrial Chemicals Co., Ashtabula. Bridgeport Brass Co., Division of National Distillers and Chemicals Corp., Niles, and Republic Steel Corp., Massillon and Canton, melted titanium. Titanium Metals Corp, of America rolled and fabricated titanium metal at Toronto. The company, owned jointly by Allegheny Ludlum Steel Corp. and National Lead Co., used primary metal shipped from its reduction plant at Henderson, Nev. Cabot Titania Corp., jointly owned by Cabot Corp. and Ruberoid Co., opened a new 20,000-ton-per-year plant at Ashtabula to produce titanium dioxide using the new chloride process. Expansion was planned to increase production to 40,000 tons per year.

Zirconium.—U.S. Industrial Chemicals Co., Division of National Distillers & Chemical Corp. produced hafnium-free zirconium sponge at Ashtabula. The company's subsidiary, Bridgeport Brass Co., produced zirconium ingots at Niles. Zirconium alloys were produced by Vanadium Corp. of America, Cambridge. Charles Taylor Sons Co., Cincinnati, processed zircon into refractories. Harshaw Chemical Co., Elyria, produced high-purity zirconium oxide.

REVIEW BY COUNTIES

Increased values were recorded in 53 of the State's 87 mineral-producing counties. Fulton County continued as the only county from which no mineral production was reported. As in 1962, Harrison, Belmont, Lake, and Summit Counties supplied over $100 million of the total value and continued to be the foremost mineral-producing areas. Values in excess of $10 million were recorded for 9 other coun-

ties; 38 other counties reported values exceeding $1 million. Sand and gravel production by Government-and-contractor operations were recorded in 15 counties, compared with 10 in 1962. County data on petroleum and natural gas operations were not available.

Adams.—Limestone was quarried at the Plum Run Quarry near Peebles by Davon, Inc. The stone was sold for concrete aggregate, blast-furnace flux, agstone, railroad ballast, and for coal mine dusting. Crews of the Adam's County Highway Department mined limestone for road construction and maintenance.

Allen.—Output of limestone totalled 696,000 tons compared with 577,000 tons in 1962. Producers were National Lime & Stone Co., and Western Ohio Stone Co., both near Lima; Suever Stone Co., Delphos; and Bluffton Stone Co., Bluffton. Western Ohio Stone Co. installed new feeder bins, and a conveyor at its plant and moved its primary crusher to the quarry. Wapak Sand & Gravel Co. produced building and paving sand and gravel at its plant near Westminster.

TABLE 11.—Value of mineral production in Ohio, by counties[1 2]

County	1962	1963	Minerals produced in 1963 in order of value
Adams	$787,526	$1,083,958	Stone.
Allen	897,184	1,162,581	Stone, sand and gravel.
Ashland	(3)	(3)	Sand and gravel, clays.
Ashtabula	(3)	(3)	Lime, sand and gravel.
Athens	1,814,440	1,584,169	Coal, stone, clays, sand and gravel.
Auglaize	(3)	(3)	Sand and gravel, stone, clays.
Belmont	27,105,589	25,924,414	Coal, stone.
Brown	53,225	56,156	Stone.
Butler	2,196,686	2,401,113	Sand and gravel.
Carroll	1,375,307	1,287,503	Coal, clays, sand and gravel, stone.
Champaign	(3)	257,616	Sand and gravel.
Clark	(3)	(3)	Sand and gravel, lime, stone.
Clermont	683,830	168,000	Stone.
Clinton	482,106	646,700	Stone, sand and gravel.
Columbiana	6,054,774	7,185,513	Coal, clays, sand and gravel.
Coshocton	8,880,000	9,887,663	Coal, sand and gravel, stone, gem stones.
Crawford	(3)	(3)	Stone, sand and gravel.
Cuyahoga	3,888,703	5,552,162	Salt, lime, sand and gravel, clays.
Darke	(3)	(3)	Sand and gravel, clays, peat, stone.
Defiance	(3)	(3)	Sand and gravel.
Delaware	1,092,466	1,299,605	Stone, lime, clays.
Erie	3,222,849	3,007,438	Stone, sand and gravel.
Fairfield	326,014	347,563	Sand and gravel.
Fayette	1,094,565	907,298	Stone.
Franklin	8,423,865	9,059,127	Sand and gravel, stone, lime, clays.
Gallia	3,175,399	2,792,228	Coal, stone, sand and gravel, clays.
Geauga	(3)	(3)	Sand and gravel, stone.
Greene	(3)	(3)	Cement, stone, sand and gravel, clays.
Guernsey	1,232,441	1,417,887	Coal, stone.
Hamilton	6,082,657	4,934,777	Sand and gravel, stone.
Hancock	(3)	(3)	Stone, sand and gravel, clays, lime.
Hardin	(3)	(3)	Stone.
Harrison	31,878,261	38,937,458	Coal, stone, clays, sand and gravel.
Henry	(3)	(3)	Sand and gravel, clays, gem stones.
Highland	(3)	(3)	Stone, sand and gravel, clays.
Hocking	325,935	(3)	Coal, clays, sand and gravel.
Holmes	1,345,271	1,383,684	Coal, clays, stone, sand and gravel.
Huron	(3)	(3)	Sand and gravel, peat.
Jackson	1,961,717	2,468,214	Coal, stone, clays.
Jefferson	12,352,897	14,967,854	Coal, clays.
Knox	(3)	(3)	Sand and gravel, stone.
Lake	(3)	(3)	Salt, lime, cement, sand and gravel, clays, stone.
Lawrence	10,911,194	10,378,255	Cement, stone, coal, clays, sand and gravel.
Licking	780,723	673,021	Sand and gravel, gem stones.
Logan	413,389	550,295	Stone, sand and gravel.
Lorain	(3)	(3)	Stone, sand and gravel, abrasives.
Lucas	(3)	(3)	Cement, stone, sand and gravel, clays.
Madison	(3)	(3)	Sand and gravel, stone.
Mahoning	(3)	(3)	Coal, stone, clay, sand and gravel.

See footnotes at end of table.

TABLE 11.—Value of mineral production in Ohio, by counties[1 2]—Continued

County	1962	1963	Minerals produced in 1963 in order of value
Marion	(3)	1,270,543	Stone, clays, sand and gravel.
Medina	(3)	(3)	Sand and gravel, clays.
Meigs	(3)	(3)	Coal, sand and gravel, salt.
Mercer	(3)	(3)	Stone, sand and gravel.
Miami	(3)	(3)	Do.
Monroe	(3)	(3)	Sand and gravel.
Montgomery	3,278,153	3,581,571	Sand and gravel, stone.
Morgan	(3)	(3)	Coal, stone, sand and gravel.
Morrow	53,260	59,250	Sand and gravel.
Muskingum	(3)	(3)	Cement, stone, sand and gravel, coal clays.
Noble	(3)	(3)	Coal, stone, clays.
Ottawa	6,404,574	7,736,895	Lime, stone, gypsum, gem stones.
Paulding	(3)	(3)	Cement, stone, clays.
Perry	(3)	(3)	Coal, sand and gravel, clays, stone.
Pickaway	(3)	(3)	Sand and gravel.
Pike	942,144	(3)	Sand and gravel, stone.
Portage	3,659,136	4,810,357	Sand and gravel, stone, coal, clays, peat.
Preble	(3)	(3)	Lime, sand and gravel, stone.
Putnam	454,323	441,384	Stone, lime, clays.
Richland	(3)	(3)	Sand and gravel, clays, peat.
Ross	(3)	(3)	Sand and gravel, stone.
Sandusky	18,565,060	21,594,400	Lime, stone, sand and gravel.
Scioto	(3)	(3)	Stone, clays, sand and gravel.
Seneca	(3)	(3)	Lime, stone, clays.
Shelby	386,871	290,348	Sand and gravel, stone.
Stark	12,144,175	13,368,449	Cement, sand and gravel, clays, coal, stone, peat.
Summit	(3)	(3)	Salt, lime, cement, stone, sand and gravel, clays.
Trumbull	(3)	182,261	Sand and gravel.
Tuscarawas	12,051,744	11,678,306	Coal, clays, sand and gravel, stone.
Union	(3)	(3)	Stone, sand and gravel.
Van Wert	(3)	606,293	Stone, clays.
Vinton	521,894	290,022	Coal, stone, clays.
Warren	932,160	1,207,435	Sand and gravel.
Washington	(3)	(3)	Sand and gravel, coal, abrasives.
Wayne	(3)	(3)	Salt, sand and gravel, coal, stone, clays.
Williams	(3)	(3)	Sand and gravel, clays.
Wood	732,062	(3)	Stone, clays.
Wyandot	(3)	(3)	Stone, lime, sand and gravel, peat, clays.
Undistributed [4]	[5] 197,090,119	201,956,582	
Total	[5] 396,055,000	419,396,000	

[1] Fulton County not listed as no production was reported.
[2] Natural gas and petroleum values are not listed by counties as data are not available; included with "Undistributed."
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Includes natural gas and petroleum, some gem stones that cannot be assigned to specific counties, and values indicated by footnote 3.
[5] Revised figure.

Ashland.—Commercial sand and gravel, mainly for building and paving, was produced principally by Young's Sand & Gravel Co., Loudonville; Bolin & Son, Ashland; and Charles Bucklew, West Salem. Output of sand and gravel by Government-and-contractor operations decreased. Shale used for heavy clay products was mined near New London by The E. Biglow Co.

Ashtabula.—Quicklime for metallurgical and chemical uses was produced at Ashtabula. Output of construction sand and gravel increased and was produced by Gleason Sand-Gravel, Inc., Conneaut; Northeast Materials, Inc., Pinney Dock & Transport Co., both of Kingsville; and Carter Sand & Gravel Co., Ashtabula. Molding sand was produced at Conneaut by Peerless Mineral Products Co.

Athens.—Coal production totaled 192,000 tons; 22 percent below that of 1962. Fifteen mines (12 underground, 2 strip, and 1 auger) were active, compared with 10 underground, 3 strip, and 1 auger in 1962. Gem Coal Co. cleaned coal by wetwashing at its No. 255 preparation plant. Limestone used exclusively for concrete aggregate was

quarried near Albany by Diamond Stone Quarries, Inc., and Shamrock Quarries, Inc. Both companies improved plant facilities; Shamrock Quarries installed a new crushing and screening plant and Diamond Stone installed two new conveyors and a new bin. Plastic fire clay was recovered from pits near Nelsonville and Haydenville for Natco Corp. The clay was used for manufacturing building brick and heavy clay products. Sand and gravel production increased slightly. Producers were Athens Sand & Gravel Co., and The F. H. Brewer Co., both near Athens; and Slater Sand & Gravel, The Plains.

Auglaize.—Processed sand and gravel was produced principally by Wapak Sand & Gravel Co., Western Ohio Stone Co., and Quality Sand & Gravel & Ready Mix Co., all near Wapakoneta. Bank run material was produced by Hardin-Coates, Inc., Wapakoneta; and Jackson Center Gravel Co., Jackson Center. National Lime & Stone Co., Buckland, produced limestone for aggregate, agstone, and railroad ballast. Clay for heavy clay products was mined near Spencerville by Sandkuhl Tile Co.

Belmont.—The county continued as the second ranking coal-producing area with an output of 6.4 million tons. Although the number of active mines increased from 37 to 40, coal output decreased 4 percent compared with that of 1962. Over 2.8 million tons of coal was processed at 5 cleaning plants. In addition, 2.1 million tons were crushed and 316,000 tons were treated with calcium chloride or oil. Limestone used mostly for aggregate was produced by Somerton Crushing Co., Somerton; McCort Bros., Barnesville; and Thomas E. Ayers Limestone Quarry, Martins Ferry. The latter company improved facilities by installing a new crusher.

Brown.—Limestone for aggregate, agstone, and other uses was quarried by the Brown County Highway Department. Howard S. Watson, Georgetown, did not produce sand as in previous years.

Butler.—The county ranked fifth (fourth in 1962) in sand and gravel production. Twelve plants, one less than in 1962, produced 2.1 million tons valued at $2.4 million. Major producers were American Materials Corp. (two plants), The Hamilton Gravel Co., Middletown Sand & Gravel Co., Ohio Gravel Co., Division of Dravo Corp., and The Moorman Sand & Gravel Co. Ross Gravel Corp. was acquired by Dravo Corp., but the plant did not operate in 1963.

Carroll.—Coal output totaled 311,000 tons, 12 percent below that of of 1962. Sixteen mines (5 underground and 11 strip) were active compared with 18 in 1962. Seven clay pits, four near Magnolia, two near Waynesburg, and one near Mineral City, were active compared with nine pits in 1962. Most of the output was fire clay used for heavy clay products and refractories. Industrial sand was produced at an operation near Mineral City. Rainbow Stone Co. produced dimension sandstone at Leavittsville. Alan Stone Co., Inc., resumed operations at its Carrollton limestone quarry after being idle in 1962.

Champaign.—Processed sand and gravel used mainly for paving was produced by American Aggregates Corp. and Miller's Excavating, Inc., both near Urbana, and Walter Dorsey, Spring Hill.

Clark.—Output of sand and gravel totaled 828,000 tons, 44 percent greater than that of 1962. Production consisted chiefly of processed construction material recovered from operations near Fairborn,

Springfield, Enon, New Carlisle, and Medway. The Moores Lime Co. quarried limestone at Springfield for commercial sales as well as for raw material for manufacturing lime and dead-burned dolomite. Quicklime and hydrated lime were produced for construction, agriculture, and industrial uses.

Clermont.—Alan Stone Co., Inc. produced limestone riprap at a portable operation near Point Pleasant. Output was used for a U.S. Army Corps of Engineers project. Operations at the Miamiville plant of Ohio Gravel Co., Division of Dravo Corp. was discontinued.

Clinton.—Limestone for aggregate, flux, agstone, and riprap was produced by Melvin Stone Co., Melvin. The company also produced processed structural sand at Sligo. Processed and unprocessed gravel was produced at Wilmington by Clinton Gravel, Inc.

Columbiana.—Output of coal increased 16 percent and totaled 1.3 million tons. Most of the output came from 33 strip mines, the remainder from 7 auger and 3 underground mines. Fire clay was recovered from pits near Negley and Wellsville. Miscellaneous clay was produced at East Liverpool, Alliance, and Summitville. Sand and gravel production increased over that of 1962. Output was from five operations, two each near Salem and Leetonia, and one near Hanoverton.

Coshocton.—Coal production totaled 2.1 million tons compared with 1.8 million tons in 1962. Seventy-seven percent of the production came from eight strip mines. In addition, six underground and three auger mines were active. Output of commercial sand and gravel totaled 628,000 tons compared with 488,000 tons in 1962. Most of the output consisted of paving material. Producers were located at Canal Lewisville, Coshocton, Newcomerstown, Walhonding, and Warsaw. Production of sand and gravel by Government-and-contractor operations was reported for the first time since 1958. Briar Hill Stone Co. produced sawed sandstone at quarries near Cavallo, New Castle, Spring Mountain, and Stillwell. Output was used in architectural applications. The Nicholl-McBride Stone Co. (formerly Variegated Quarries Division, Nicholl Stone Co.) also quarried sandstone for architectural uses. The stone was processed at Killbuck, Holmes County. Specimens of flint were collected for their mineralogical interest.

Crawford.—National Lime & Stone Co. at its Spore quarry near Bucyrus, produced limestone for flux, aggregate, agstone, and railroad ballast. Limestone also was produced under contract for the Crawford County Highway Department for road construction and maintenance. Sand and gravel used for building, paving, and fill material was produced by Galion Gravel Co., Galion.

Cuyahoga.—Rock salt was recovered from the Cleveland underground mine of International Salt Co. The company continued development and improved facilities by installation of an underground preparation plant. Limestone shipped by boat from Michigan was burned at the Cleveland plant of Cuyahoga Lime Co. Output was mainly metallurgical quicklime for use at nearby steel mills. Sand and gravel production by commercial operations increased from 696,000 tons in 1962 to 993,000 tons. Output consisting primarily of construction material was reported from nine operations. Output by Government-and-contractor operations decreased. Clay was produced by Cleveland Builders Supply Co., two operations near Cleveland;

Hydraulic-Press Brick Co. and Cleveland Pottery Co., both near Independence; and The Ohio Clay Co., Garfield Heights. Most of the output was used for manufacturing brick and lightweight aggregate. Cleveland Gypsum Co., division of Cleveland Builders Supply Co., processed crude perlite and vermiculite shipped from outside the State.

Darke.—Sand and gravel used principally as paving and fill material was produced by American Aggregates Corp., Foureman's Gravel, Shields Gravel Pit, and Slagle Gravel Co., all near Greenville, and Hollinger Gravel Plant, New Madison. Clay used for heavy clay products was produced at Greenville and Versailles. Lakeland Valley Organic Products produced calcareous marl for agricultural purposes at New Madison. Humus peat was produced at Woodington by Louie Meyer.

Defiance.—Ohio Materials, Ney, and Northwest Materials, Defiance, produced sand and gravel.

Delaware.—National Lime & Stone Co., Delaware; The Owens Stone Co., Ostrander; Marble Cliff Quarries Co., Powell; and Penry Stone Co., Radnor, produced limestone used chiefly for aggregate and agstone. Scioto Lime & Stone Co., Inc. produced quicklime and hydrated lime at Delaware chiefly for water purification and sewage treatment. Galena Shale Tile & Brick Co., Galena, and Delaware Clay Co., Westerville, produced shale. No commercial or Government-and-contractor sand and gravel output was reported.

Erie.—Castalia Quarries Co., Castalia; Sandusky Crushed Stone Co., Inc., Parkertown; and Wagner Quarries Co., Sandusky, produced limestone chiefly for aggregate, railroad ballast, agstone, and riprap. Foundry sand was produced by Ohio Foundry Sand Co., Shinrock, and Keener Sand & Clay Co., Huron. Bank-run fill gravel was produced at Castalia.

Fairfield.—Sand and gravel output decreased from that reported in 1962. The material was chiefly for paving and building. Principal producers were The F. H. Brewer Co. and Febus Gravel Co., both near Lancaster. Some production was reported by Government-and-contractor operations.

Fayette.—Production of limestone decreased from 660,000 tons in 1962 to 631,000 tons. Output was reported by Blue Rock, Inc., Greenfield, and Fayette Limestone Co., Inc., and Sugar Creek Stone Quarry, Inc., both near Washington Court House. Most of the material was sold for aggregate and agstone.

Franklin.—The county became the leading sand and gravel-producing area, replacing Hamilton County. Output increased 28 percent above that of 1962, totaling 4.9 million tons. Fifteen companies reported production, compared with 14 in 1962. Most of the material was processed chiefly for building and road construction. Leading commercial producers were American Aggregates Corp. (three plants) and Miller Sand & Gravel, both of Columbus. Marble Cliff Quarries Co., Columbus, produced limestone for a variety of uses and quicklime and hydrated lime at its nearby plant. Clay for heavy clay products was produced by The Claycraft Co. and The Columbus Clay Manufacturing Co., both near Blacklick. No production of reed-sedge peat was reported from the Grove City operation of W. C. Utzinger & Sons.

Gallia.—Coal production totaled 643,000 tons compared with 760,000 tons in 1962. Twenty mines were active compared with 22 the previous year. Coal was cleaned at the Cheshire plant of Peacock Coal Co. Limestone used chiefly for aggregate was produced near Bidwell by James Merry Stone Co. The M. T. Epling Co., Gallipolis, produced sand and gravel for building and road construction. Molding sand was produced by The Keener Sand & Clay Co., Kerrs. Shale for floor and wall tile was mined near Waterloo by Jess Brammer. During the year, Jess Brammer replaced his old mining equipment.

Geauga.—Output of commercial sand and gravel totaled 651,000 tons, a decrease of 28 percent compared with 1962. Leading producers were R. W. Sidley, Inc., Northern Ohio Materials, Inc., and Jefferson Materials Co. Harbison-Walker Refractories Co., Thompson, quarried quartzite for refractory brick.

Greene.—Southwestern Portland Cement Co. and Universal Atlas Cement Division of United States Steel Corp., both near Fairborn, produced types I–II (general use) and type III (high-early-strength) portland and masonry cements. Finished cement was shipped principally to consumers in Ohio, Indiana, and Kentucky. Both companies mined limestone and clay as raw materials for cement. Blue Rock, Inc., did not produce limestone at its Cedarville quarry. Sand and gravel output increased 8 percent and totaled 1 million tons, continuing an upward trend since 1961. Principal producers were Hilltop Concrete Corp., Fairborn; Morrow Gravel Co., Spring Valley; The Xenia Sand, Gravel & Asphalt Paving Co., Xenia; and Phillips Sand & Gravel Co., Alpha. Most of the output was processed for construction and paving.

Guernsey.—Output of coal increased 32 percent and totaled 368,000 tons. The number of active mines increased from 9 to 11. Virginia Mining Co. cleaned coal by wet washing at its Carroll No. 2 plant. Limestone for concrete aggregate was produced by John Gress & Sons, Inc., New Concord.

Hamilton.—The county was replaced by Franklin County as the leading sand and gravel-producing area. Production was 4.1 million tons compared with 4.5 million tons in 1962. Thirteen principal operations, most of them near Cincinnati, were active. Ohio Gravel Co., Division of Dravo Corp., with plants at Camp Dennison, Cleves, Miamitown, and Newtown, continued to be the leading producer. Limestone for agstone was recovered as a byproduct of sand and gravel production at the Newtown and Camp Dennison plants of Ohio Gravel Co. Crude perlite shipped from Colorado was expanded for insulation material at the Cincinnati plant of Philip Carey Manufacturing Co.

Hancock.—National Lime & Stone Co. and The Tarbox-McCall Stone Co., both near Findlay, and Pifer Stone Co., Williamstown, produced limestone chiefly for aggregate. Tarbox-McCall Stone Co. installed a washing plant at its operations. H. & M. Sand & Gravel Co., Findlay, produced building, paving, and filter sand and gravel. Clay for heavy clay products was produced by Hancock Brick & Tile Co., Findlay. The Northern Ohio Sugar Co., a subsidiary of The Great Western Sugar Co., produced and used quicklime for sugar refining at Findlay. The company used limestone quarried in Michigan for their lime kilns.

Hardin.—Hardin Quarry Co., Dunkirk, and Herzog Lime & Stone Co., Forest, produced limestone chiefly for aggregate. Hardin Quarry Co. installed a stone washer at its plant.

Harrison.—The county continued to rank first in output among the State's 25 coal-producing counties. Compared with 1962, output of coal increased 24 percent and totaled 9.7 million tons. The number of active mines increased from 24 to 28. Most of the coal was cleaned at the Georgetown plant of Hanna Coal Co., Division of Consolidation Coal Co., and the Nelms plant of Youghiogheny & Ohio Coal Co. In addition, a substantial quantity of coal was crushed and treated for dust prevention and antifreezing. Hanna Coal Co. also quarried limestone for aggregate and agstone at Cadiz. Shale for drain tile was produced by The Bowerston Shale Co., Bowerston. Commercial production of sand and gravel was reported in the county.

Henry.—Turkey Foot Sand & Gravel and Napoleon Sand & Gravel Co., both near Napoleon, produced mainly construction sand. Clay for drain tile was produced by August Honeck & Son, Malinta, and Napoleon Brick & Tile Works, Napoleon. August Honeck changed from fuel oil to propane gas for heating its kilns. Mineral specimens collected in the county included calcite and marcasite.

Highland.—Highland Stone Division, Davon, Inc., and Marshall Quarry, both near Hillsboro, and Ohio Asphaltic Limestone Co., Inc., New Vienna, produced limestone for aggregate and agstone. Sand and gravel used mainly for construction was produced from pits near Greenfield, Hillsboro, and Leesburg. The Mowrystown Brick & Tile Co., Mowrystown, mined clay for building brick and drain tile.

Hocking.—Coal production increased from 68,000 tons in 1962 to 81,000 tons; the number of active mines remained at seven. General Hocking Brick Co. mined plastic fire clay and shale from pits near Logan. Nutter Bros. Coal Co. mined shale from a pit near New Straitsville. Output from both operations was used for building brick. Commercial and Government-and-contractor sand and gravel was produced in the county.

Holmes.—Output of coal increased 23 percent and totaled 299,000 tons. One underground and four strip mines continued active. Holmes Clay Division of Holmes Limestone Co. produced plastic fire clay and limestone at Berlin. Clay also was mined by Beldin Brick Co. and Massillon Refractories Co., both near Berlin; General Clay Products Co., Baltic; and Clark Clay Co., Millersburg. The latter company acquired a new bulldozer for their mining operations. Construction sand and gravel was produced by Close Sand & Gravel Co. and Feikert Sand & Gravel, both near Millersburg, and Gallo & Sons, Inc., Holmesville. Briar Hill Stone Co. at two quarries and The Nicholl-McBride Stone Co. (formerly Variegated Quarries Division, The Nicholl Stone Co.) produced sandstone chiefly for architectural applications.

Huron.—Huron Sand & Gravel Co., Inc., produced structural and paving gravel at New London. Mel-lo Peat Co., Willard, produced humus peat.

Jackson.—Coal production was 412,000 tons compared with 301,000 tons in 1962. Seven underground and 12 strip mines were active compared with 6 underground and 11 strip mines in 1962. Waterloo

Coal Co., Inc. cleaned coal by wet washing at its Waterloo plant. The company also produced clay and limestone at Oak Hill. Clay was produced at Oak Hill by Pyro Refractories Division, A. P. Green Fire Brick Co. and Cedar Heights Clay Co. All of the clay output was used in refractory applications.

Jefferson.—Output of coal totaled 3.9 million tons, an increase of 20 percent over that of 1962. The county continued to rank third in coal production. Fifty-five mines (33 strip, 9 underground, and 13 auger) were active compared with 56 mines in 1962. Coal cleaning plants were operated by North American Coal Corp. and Hanna Coal Co., Division of Consolidation Coal Co. Over 1.3 million tons of coal was crushed at 11 plants. Clay production, consisting chiefly of fire clay for refractories, was recovered from pits near Irondale, Toronto, and Empire. Total clay output was slightly below that of 1962.

Knox.—Production of sand and gravel totaled 715,000 tons, 17 percent lower than in 1962. Most of the output came from operations near Brinkhaven, Gambier, Fredericktown, and Mount Vernon. The Millwood Sand Co., Howard, produced molding, glass, and ground sand. Briar Hill Stone Co. operated two sandstone quarries for the production of architectural stone.

Lake.—Morton Salt Co. produced rock salt at its Fairport underground mine near Painesville. The company installed a dust collecting system and acquired a bulldozer for use in stacking crushed salt. Diamond Alkali Co., Painesville, produced quicklime and salt brine from nearby wells. The brine and quicklime were used for manufacturing chlorine and alkalies. Grand River Lime Co., Grand River, produced quicklime from limestone quarried in Michigan and transported to the plant by boat. The quicklime was sold for metallurgical and water purification purposes. Standard Portland Cement Division, Diamond Alkali Co. produced portland and masonry cements at Painesville, using clay mined nearby and purchased limestone and gypsum. Finished portland and masonry cements were shipped principally to consumers in Ohio and Western Pennsylvania. Commercial output of sand and gravel increased above that of 1962. Production was principally from operations near Willoughby and Mentor. Output by Government-and-contractor operations totaled 112,000 tons. D. R. Keeney Gravel Co. produced sandstone for rubble and bank run gravel at Painesville.

Lawrence.—Portland and masonry cements were produced by Alpha Portland Cement Co., Ironton, and Marquette Cement Manufacturing Co., Superior. Alpha-mined limestone and sandstone and Marquette mined limestone and shale for use as cement raw materials. Finished portland and masonry cement was shipped to consumers in Ohio, West Virginia, Kentucky, and Virginia. W. E. Engle Stone Co., Pedro, also quarried limestone for concrete aggregate and riprap. Limestone for road construction and repair was produced by the Lawrence County Highway Department. Mostly fire clay was recovered at pits near Blackfork, Coal Grove, Ironton, Pedro, and South Webster. Wilson Sand & Gravel Co., Chesapeake, and Jerry Sand & Gravel, Inc., South Point, produced construction sand and gravel. Lawrence Refractories Co., Pedro, produced industrial sand. Coal production continued to decline as the number of active strip

mines decreased from five in 1962 to four. County production was exclusively strip-mined coal. Collins Mining Co. operated a cleaning plant using jig equipment.

Licking.—Output of sand and gravel totaled 708,000 tons, 5 percent less than that of 1962. Fourteen principal operations were active. Output, consisting mainly of construction material, was produced at Granville, Kirkersville, Newark, St. Louisville, and Thornville. Mineral specimens of jasper, agate, and flint were recovered in the county.

Logan.—Limestone production totaled 381,000 tons compared with 236,000 tons in 1962. Producers were Connolly Construction Co., East Liberty, C. E. Duff & Son, Inc., Huntsville, and Northwood Stone & Asphalt Co., Belle Center. The latter company improved facilities and installed a screen to meet State specifications. Sand and gravel was recovered at operations near Bellefontaine, Huntsville, Quincy, and Zanesfield.

Lorain.—Cleveland Quarries Co., Amherst, and The Nicholl-McBride Stone Co., Kipton, produced dimension sandstone used chiefly in architectural applications. Cleveland Quarries also fabricated stone for lining steel furnaces. Grindstones were recovered as a byproduct at the Kipton operation of The Nicholl-McBride Stone Co. Sand and gravel was recovered at four operations; output was below that of 1962. National Gypsum Co., Lorain, produced calcined gypsum for use in manufacturing building products.

Lucas.—Medusa Portland Cement Co. produced portland cement at Toledo, mainly from limestone, shale, and sand mined nearby. The company produced types I–II (general use) portland cement for shipment to consumers in Ohio, Michigan, and Indiana. Limestone used chiefly for aggregate was produced by the France Stone Co., Waterville, Stone Co., Maumee, and Toledo Stone & Glass Sand Co., Sylvania. The Toledo House of Correction, Whitehouse, produced rough blocks and rubble at its limestone quarry. In addition to Medusa Portland Cement Co., sand production was reported from six other operations mainly near Toledo. No gravel production was reported. Output decreased and was used primarily for construction.

Madison.—The West Jefferson Sand & Gravel Co., West Jefferson, and McMullen Sand & Gravel Co., Inc., Mount Sterling, produced construction sand and gravel. Output of 150,000 tons of paving gravel was reported by the Ohio State Highway Department. Madison Stone Co., Inc., Galloway, and Connolly Construction Co., Plain City, produced limestone. The Darby quarry of Connolly Construction Co. was sold in December to American Aggregates Corp. The London clay pit of The Madison Tile Co. did not operate.

Mahoning.—Coal production totaled 913,000 tons, 13 percent below that of 1962. Sixteen strip mines were active, three less than the number in 1962. Limestone for flux, aggregate, and agstone was produced by Carbon Limestone Co., Lowellville. Alliance Stone Co. produced limestone aggregate at Smith Township. Alliance Brick Corp. produced miscellaneous clay from pits near Alliance and Beloit. Fire clay was produced by Natco Corp., Petersburg, and American Fire Clay Co., Canfield. Sand and gravel was produced at North Lima by Atlas Sand and Gravel Co. No reed-sedge peat production was reported by Beaver Peat Products Co., Damascus.

Marion.—Output of limestone used mainly for aggregate and agstone totaled 589,000 tons compared with 620,000 tons in 1962. Producers were National Lime & Stone Co., J. M. Hamilton & Sons Co., both near Marion, and Tri County Limestone Co., La Rue. Shale for manufacturing building brick was produced by Marion Brick Corp., Iberia. Output of sand and gravel continued to increase. Production was reported principally from three operations, one each near Radnor, Prospect, and Green Camp.

Medina.—Production of sand and gravel totaled 584,000 tons, 19 percent above that of 1962. Principal producers were Quillin Bros. Construction Co., Inc., and Lodi Sand & Gravel, both near Lodi, Seville Sand & Gravel, Inc., Seville, and Ray H. Taylor Trucking & Supply, Medina. Wadsworth Brick & Tile Co., Wadsworth, mined clay for building brick.

Meigs.—Output of coal increased from 258,000 tons in 1962 to 346,000 tons in 1963. Eighteen mines were active, one less than in 1962. Output of sand and gravel continued a downward trend begun in 1961, decreasing 4 percent compared with that of 1962. Producers were Richards & Sons, Inc., and Tri-State Materials Corp., both near Apple Grove, and Goeglein Gravel Co., Middleport. Excelsior Salt Works, Inc., produced evaporated salt in open pans at Pomeroy.

Mercer.—Limestone used mainly for aggregate and agstone was produced by The John W. Karch Stone Co., Celina, and Rockford Stone Co., Rockford. Commercial sand and gravel production was reported.

Miami.—Armco Steel Corp. produced limestone chiefly for metallurgical flux at Piqua. Output of sand and gravel increased 10 percent over that of 1962 and totaled 513,000 tons. Principal producers were Troy Gravel Co., Troy, and Steiner's Sand & Gravel Co., Ludlow Falls. Other areas of production included Bradford, Covington, Piqua, and Vandalia. Most of the output was processed mainly for construction.

Monroe.—Processed sand and gravel was produced by Blaney Sand & Gravel, Inc., Clarington. Bank run gravel was produced at the Witten Gravel pit near Fly by Watson Piatt.

Montgomery.—Commercial production of sand and gravel totaled 2.6 million tons, 6 percent above that of 1962. The county ranked fourth among the producing areas. Output was reported from 21 principal operations. Leading producers included American Aggregates Corp., two plants near Dayton; Keystone Gravel Co. and Moraine Materials Co., both near Dayton; Hilltop Concrete Corp., West Carrollton; Miller Bros., Tipp City; and Wysong Gravel Co., with plants near Dayton and Germantown. Output by Government-and-contractor operations increased over that of 1962. American Aggregates Corp. operated limestone quarries near Dayton and Phillipsburg. The company installed a ready mixed concrete facility at the Phillipsburg operation. Output from both quarries was mainly for aggregate. Limestone also was produced by Carey Brothers Stone Co., near Dayton. The City of Dayton Water Department recovered lime from waste sludge and from the recarbonation of water in its purification and softening process. Most of the material was used by

the department, but surplus quicklime was sold to other municipalities for water treatment.

Morgan.—Although the number of active strip mines decreased from four in 1962 to three, output of coal increased 11 percent and totaled 2.5 million tons. Central Ohio Coal Co. produced most of the output from its Muskingum mine and cleaned the coal at its preparation plant. D. & K. Construction, Inc., Reinersville, and Ball & Ball, Amesville, produced limestone. Stockport Sand & Gravel Co., Stockport, produced building and paving sand and gravel.

Morrow.—Construction sand and gravel was produced by Chesterville Sand & Gravel Co., Chesterville.

Muskingum.—Columbia Cement Corp. produced portland and masonry cement at its East Fultonham plant. At Zanesville, the company mined limestone underground and recovered shale from an open pit for use as the principal cement raw materials. At the limestone mine the company installed a surge bin. Most of the finished cement was shipped to consumers in Ohio and West Virginia. Limestone was produced by Chesterhill Stone Co., East Fultonham, and Sidwell Brothers, Zanesville. Chesterhill Stone Co. added three bins for truck loading. The Cumberland limestone quarry of D. & K. Construction, Inc., did not operate in 1963. Output of sand and gravel increased compared with that of 1962. Principal producers were The Zanesville Gravel Co., Dresden, and Muskingum River Gravel Co., Zanesville. Shale for building brick was produced by The Bowerstown Shale Co., Frazeysburg. Stoneware clay was produced by Ivan L. Hammer, East Fultonham. Output of coal dropped from 274,000 tons in 1962 to 103,000 tons. Seven underground and five strip mines, the same as in 1962, were active.

Noble.—Coal production totaled 1.8 million tons, 24 percent greater than in 1962. Production was reported from 10 strip and 6 auger mines. Central Ohio Coal Co. processed coal by wet washing at its cleaning plant. Limestone mainly for aggregate was produced by Lawrence King, Cumberland; James Merry Stone Co., Caldwell; Herman Zerger, Jr., Stock Township; and Piatt Quarry, Summerfield. James Merry Stone Co. installed a new 42-inch crusher; Lawrence King installed an additional grinder for the production of agstone. The Ava Brick Corp. produced shale for manufacturing building brick at Ava.

Ottawa.—United States Gypsum Co., Genoa, produced quicklime and hydrated lime from limestone quarried nearby. The lime was used chiefly for construction. The company made some commercial sales of limestone. Marblehead Stone Division, Standard Slag Co. quarried limestone at Marblehead mainly for aggregate and flux. The company extended and improved its operation by adding blending, stocking, and washing facilities. Basic, Inc., produced limestone for aggregate at Clay Center; the lime plant remained idle. Celotex Corp., Port Clinton, and United States Gypsum Co., Gypsum, mined crude gypsum. The crude material was calcined at nearby plants for use in manufacturing finished building products. Mineral specimens of celestite were collected near Clay Center.

Paulding.—Peninsular Portland Cement Division, General Portland Cement Co., Paulding, produced portland and masonry cements.

Limestone and clay mined nearby and purchased sand and gypsum were used as the principal cement raw materials. Some of the finished cement was transferred to the company's Cement City, Michigan, plant; the remainder was sold to customers in Ohio, Indiana, and Michigan. Some of the limestone from the Peninsular quarry was shipped to the Michigan plant for processing and some was sold to The France Co. locally for further processing and sale as aggregate, agstone, and railroad ballast. Auglaize Stone Co. operated a limestone quarry at Oakwood for the production of aggregate, agstone, and flux. Junction Quarry, Inc., Junction, went out of business. Baughman Tile Co. and Dangler Drain Tile Co., both near Paulding, and Haviland Clay Works Co., Haviland, mined clay for drain tile.

Perry.—Output of coal totaled 2 million tons, 4 percent greater than that of 1962. Nineteen mines (9 underground, 8 strip, and 2 auger) were active. Peabody Coal Co. and Sidwell Bros. Coal Co. operated cleaning and preparation plants. Industrial sands were produced by Central Silica Co., Glenford, and The Keener Sand & Clay Co., New Lexington. Limited production of paving sand was reported by the Ohio State Highway Department. Eight clay operations were active. Production was reported from Gore, Junction City, Logan, New Lexington, Saltillo, Somerset, and Shawnee. Limestone was produced by Maxville Stone Co., Logan, and Morris Bros. Lime & Stone, Rushville. Morris Bros. improved facilities by adding a stockpiling elevator and a vibrator to their operation.

Pickaway.—The Strum & Dillard Co., Circleville, produced processed sand and gravel. McFarland Co. produced bank-run gravel at Circleville.

Pike.—Output of construction sand and gravel decreased compared with that of 1962. Operations were active near Waverly, Lucasville, and Sargents. Industrial sand and gravel was produced at Jackson. Durex Division, A. P. Green Fire Brick Co. and Cambria Clay Products Co. produced quartzite at Beaver.

Portage.—Output of sand and gravel totaled 2.2 million tons, 13 percent greater than in 1962. Production was reported from 22 operations mainly near Ravenna, Kent, and Mantua. Industrial Silica Division, Pennsylvania Glass Sand Corp., produced industrial sands at the Geauga works near Aurora and at the Portage works near Garrettsville. Leading producers of construction sand and gravel included The Hugo Sand Co., Hilltop Sand & Gravel Co., and Twin Lakes Sand, Inc., all near Kent; The Standard Slag Co. and Solon Sand & Gravel, both near Mantua; and Stroup & Sons Sand & Gravel, Inc., Mogadore. Harbison-Walker Refractories Co. and General Refractories Co. produced quartzite for silica brick. United States Concrete Pipe Co. mined shale for manufacturing vitrified sewer pipe at Diamond. Peterson Coal Co. continued as the only coal producer. The company strip-mined coal and processed the output at its Atwater cleaning plant. Greene Oaks Peat Moss Co. and Portage Peat, both near Ravenna, produced peat.

Preble.—Marble Cliff Quarries Co. quarried limestone to supply its Lewisburg lime plant and for sale as aggregate, agstone, and flux. The company produced quicklime and hydrated lime for chemical and other industrial uses. Construction sand and gravel was produced by

White Gravel Co., Camden; Steiner's Sand & Gravel Co. and Blue Bank Gravel Co., both near West Alexandria.

Putnam.—Limestone used chiefly for aggregate was quarried by National Lime & Stone Co., Columbus Grove; The Putnam Stone Co., Ottawa; and Ottawa Stone Co., Gilboa. Buckeye Sugars, Inc., Ottawa, produced and used quicklime for sugar refining. The company burned limestone shipped from Michigan. Glandorf Tile Co., Glandorf; Etter Tile & Coal Co., Dupont; Miller Bros. Clay Works, Inc., Ottoville; and Leipsic Clay Products Co., Leipsic, mined clay for drain tile.

Richland.—Production of commercial sand and gravel totaled 341,000 tons compared with 336,000 tons in 1962. Producers were D. H. Bowman & Sons, Inc., and Derwacter Sand & Gravel, both near Bellville; The Mohican Sand & Gravel Co., Perrysville; and H. W. Fleck & Son, Inc., Lexington. Shale for manufacturing brick was produced by The Richland Shale Brick Co. and Ohio Brick & Supply Co., both near Mansfield. Reynolds Farms, Inc., produced moss peat near Shelby.

Sandusky.—The county continued to lead in production and value of limestone and lime. Output of lime, including dead-burned dolomite, increased 13 percent and totaled 996,000 tons valued at $16.1 million. Most of the output was dead-burned dolomite used as refractory material by the steel industry. The number of active lime plants remained at eight. Limestone production totaled 3.6 million tons, 32 percent greater than that of 1962. Limestone was used for manufacturing lime (55 percent), aggregate (15 percent), metallurgical flux (15 percent), and other uses including agstone. Limestone was quarried at operations near Bellevue, Fremont, Gibsonburg, Millersville, and Woodville. Several companies improved operations during the year; The J. E. Baker Co., Millersville, installed coal storage facilities; Gibsonburg Lime Products Co., Gibsonburg, added a secondary crusher, trucks, and a brickette machine; and The Gottron Brothers Co., Inc., Fremont, acquired an end loader. Home Supply Center, Inc., (formerly Home Sand & Coal Co.) recovered structural sand by dredging at Fremont.

Scioto.—Waller Bros. Stone Co. and The Taylor Stone Co., both near McDermott, produced dimension sandstone for furnace brick and architectural uses. General Refractories Co. produced quartzite for silica brick at Minford. Fire clay was produced by Industrial Minerals Division, International Minerals & Chemical Corp., Wheelersburg, William and James Belcher, Scioto Furnace, and Myrl C. Ruby, Portsmouth. Construction sand and gravel was produced by The Standard Slag Co., Haverhill; Lucasville Sand & Gravel, Lucasville; Earl H. Schilling & Son, Franklin Furnace; and Robert L. Rowe, Wheelersburg.

Seneca.—Basic, Inc., mined dolomite and produced dead-burned dolomite at Maple Grove. Stone also was sold for aggregate, metallurgical flux, and agstone. The France Stone Co. and Webster Stone Co., both near Bloomville, and Northern Ohio Stone Co., Flat Rock, produced limestone mainly for aggregate. J. A. Miller Tile Co., Bascom, and St. Stephen Tile Co., Bloomville, mined clay for drain tile.

747-416—64——55

Shelby.—Sand and gravel production declined compared with 1962. Output was principally by The Sidney Sand & Gravel Co., Sidney; The Ernst Gravel Co., Houston; and Spring Creek Gravel Co., Fort Laramie. Limestone for aggregate and riprap was produced by Miami River Quarries, Inc., Sidney.

Stark.—Diamond Portland Cement Co., Division of The Flintkote Co., produced portland and masonry cements at Middle Branch from limestone and shale mined nearby. Finished cement was shipped to consumers in Ohio, Pennsylvania, West Virginia, New York, and Kentucky. Output of commercial sand and gravel totaled 2 million tons, 4 percent greater than in 1962. Eighteen operations were active; most of the output was processed construction material. Limited production was reported by Government-and-contractor operations. Major commercial producers included The Standard Slag Co., Massillon; Canton Aggregate Co., with four plants near Canton; Massillon Washed Gravel Co., Navarre; Ray C. Oster, Canton; and Uniontown Sand & Gravel Supply, Inc., Uniontown. Industrial sand was produced at Canal Fulton by Tuscora Foundry Sand Co. Clay production was reported from 20 operations, the same as in 1962. Most of the output was fire clay for refractories and heavy clay products. Operations were located throughout the county. Limestone was produced by East Ohio Limestone Co., Hartville, Alborn Coal & Lime Co., East Sparta, and ELMCO Limestone & Coal Co., Canton. Output of coal decreased 13 percent below that of 1962 and totaled 572,000 tons. All production was from 19 strip mines, the same as in 1962. Peat was produced by Gerald R. Hetrick, Lab Nursery & Peat Moss, Lantz Peat Moss, Inc., and Sanders Peat Moss, all near Canton.

Summit.—The county's mineral industry was predominated by the various mining and processing activities of Pittsburgh Plate Glass Co., Chemical Division at Barberton. The company produced evaporated salt and brine, limestone, sandstone, portland cement, and quicklime. Chlorine and caustic soda was produced by the electrolysis of the salt brine. The brine solution also was combined with quicklime to produce soda ash. Limestone recovered from the company's nearby underground mine was the principal raw material for the lime plant (six coal- and coke-fired shaft kilns) and the single rotary cement kiln. Some limestone was sold for aggregate. Evaporated salt was sold for various chemical uses. Output from the company's sandstone quarry was used in glass manufacture and as concrete aggregate. Diamond Crystal Salt Co. produced salt brine at Akron. Most of the brine was evaporated in both open and vacuum pans and sold for a variety of uses. Some of the salt was marketed as pressed blocks; some brine was sold to the rubber industry. The company added and replaced some material handling equipment. Sand and gravel production totaled 917,000 tons compared with 994,000 tons in 1962. Output was reported by 14 principal operations, mainly near Akron, Barberton, and Stow. The Robinson Clay Products Co. mined plastic fire clay and shale at Mogadore. Camp Brick Co., Mogadore, mined shale for building brick.

Trumbull.—The Kinsman Sand & Gravel Co., Kinsman, produced building, paving, and fill sand and gravel.

Ross.—Sand and gravel production totaled 676,000 tons compared with 575,000 tons in 1962. Most of the output was processed construc-

tion material. Producers included Central States Construction Co., Brewer & Brewer Sons, Inc., and Chillicothe Sand & Gravel Co., all near Chillicothe; and Miami Gravel Co., Richmond Dale. Paving sand and gravel, as well as limestone for aggregate and agstone was produced at Bainbridge by Ohio Asphaltic Limestone Co. Sandstone for foundry use and glass manufacture was quarried by Southern Silica, Inc., Richmond Dale. The company improved facilities by installing new screening equipment, a dryer, and a dust collector. Chillicothe Division, The Mead Corp., produced and used regenerated quicklime for manufacturing paper at Chillicothe.

Tuscarawas.—Coal production decreased 2 percent below that of 1962; 51 mines (33 strip, 11 underground, and 7 auger) were active. Pittsburgh Plate Glass Co. operated its Midvale cleaning plant. Clay production decreased slightly but the county continued as the leading clay-producing area. Twenty-six mines were active compared with 24 in 1962. Seventy-three percent of the total output was fire clay used chiefly for refractories and heavy clay products. Miscellaneous clay was used chiefly for heavy clay products and floor and wall tile. Leading producers included The Belden Brick Co., The Claycraft Co., The Evans Pipe Co., Fox Valley Mining Co., Goshen Brick & Clay Corp., Shepfer & Moomaw Brothers, Inc., and The Stone Creek Brick Co. Production at the latter company was curtailed because of installation of new tunnel kilns in the brick plant. Kimble Limestone Co. produced clay and limestone at Dover. During the year, the company acquired larger trucks for mine haulage. Limestone also was produced by Bonum Lime Co. at Sugar Creek. Dundee Stone Co., Inc. (formerly Yoder Stone Co.), quarried sandstone for architectural work at Dundee. Output of sand and gravel was 649,000 tons, 14 percent higher than in 1962. Eight operations reported production, compared with nine in 1962. Industrial Silica Division, Pennsylvania Glass Sand Corp., produced industrial sands at the Coxey Works near Dundee. Leading producers of construction material were Stocker Sand & Gravel Co., Ghadenhutten; Edgar Spring, Inc., Sandyville; and Spring Brothers, New Philadelphia.

Union.—Limestone for construction and agstone was produced by Union Limestone, Inc., Ostrander, and L. G. Rockhold & Sons, York Center. Marysville Concrete & Materials, Inc., Marysville, produced construction sand and gravel.

Van Wert.—Limestone production decreased compared with 1962. Producers were The Union Quarries Co. and Ridge Township Stone Quarry, both near Van Wert, and Delphos Quarries Co., Delphos. Delphos Quarry replaced two gyratory crushers with a new impact crusher, replaced stone loading conveyors and installed a new stone feeder. Ridge Township Stone added a secondary crusher and a conveyor belt system. Weck Tile Plant, Van Wert, mined clay for drain tile. Delphos Clay Works Co., Delphos, discontinued business.

Vinton.—Coal production continued to decline; output was 53,000 tons compared with 101,000 tons in 1962. Four underground and two strip mines were active compared with eight and five, respectively in 1962. McArthur Stone & Coal Co., McArthur, produced limestone for aggregate and agstone. Hope Fire Clay Co., Zaleski, mined fire clay for refractories. The McArthur Brick Co., McArthur, ceased mining operations and discontinued manufacturing brick.

Warren.—For the 2d consecutive year, output of sand and gravel increased. Most of the material was processed for building and paving. Principal producers were Morrow Gravel Co. and Ohio Gravel Co., Division of Dravo Corp., both near Morrow; Franklin Sand & Gravel Co., Inc., and Martz Bros. & Earnhart, Inc., both near Franklin; and Michael Concrete Products, Inc., Loveland. No limestone or sand and gravel production was reported by Government-and-contractor operations.

Washington.—Output of coal decreased. The number of active mines (three strip and one auger) was below that of 1962. Sand and gravel production increased compared with 1962. Fred Price Contracting Co., Waterford, and Muskingum River Gravel Co., New Matamoras, were the principal producers. Output also was reported from operations near Marietta and Little Hocking. Hall Grindstone Co. produced abrasive stone (grindstone) at Constitution.

Wayne.—Evaporated salt was produced by vacuum and open pans at Rittman by Morton Salt Co. The company added a power substation to its operations. In contrast with the 5 previous years, which increased, output of sand and gravel decreased. Leading producers were Prairie Lane Gravel Co., Wooster, and The Rupp Construction, Inc., Marshallville. Limestone and plastic fire clay was produced by Mullet Coal Co. at Mount Eaton. Wayne County Quarries, Inc., produced limestone for aggregate at Fredericksburg. Medal Brick & Tile Co., Wooster, and Orrville Tile Co., Orrville, produced clay for heavy clay products. Coal production increased; all production was from two strip mines.

Williams.—Commercial sand and gravel production decreased for the 2d consecutive year. Output consisted chiefly of processed construction material. Tri-State Gravel Co., Montpelier, was the foremost producer. The Stryker Drain Tile Co., Stryker, mined clay for drain tile.

Wood.—Limestone production increased 25 percent, totaling 717,000 tons. Producers were The Brough Stone Co., West Millgrove; The France Stone Co., North Baltimore and Luckey; Maumee Stone Co., Perrysburg and Portage; and The Pugh Quarry Co., Custar. Rossford Brick & Tile Co., Perrysburg, resumed mining operations for the production of clay for drain tile. During the year the company installed new grinding and screening equipment. Perrysburg Tile & Brick Co., Perrysburg, continued idle while the plant underwent repairs and remodeling work.

Wyandot.—National Lime & Stone Co. quarried limestone and produced lime at Carey. Limestone was used at the lime plant but most of the material was sold for a variety of uses. Output at the lime plant consisted chiefly of quicklime for the glass industry. Quicklime was shipped chiefly to consumers in Indiana, Pennsylvania, Illinois, and New Jersey. Limestone also was produced by Kuenzli Quarries Co., Inc., and J. L. Foucht Quarry, both near Upper Sandusky, and Wyandot Dolomite, Inc., Carey. Sand and gravel output increased compared with 1962. Principal producers were Corfman Gravel Co., Wilson Sand Co., and Kuenzli Quarries Co., Inc., all near Upper Sandusky. The Claycraft Co., Upper Sandusky, mined shale for building brick. Humus peat was produced by The Humus Co., Carey.

The Mineral Industry of Oklahoma

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Oklahoma Geological Survey for collecting information on all minerals except fuels.

By Robert B. McDougal [1] and William E. Ham [2]

MINERAL OUTPUT in Oklahoma in 1963 was valued at $873 million, $17.2 million more than in the previous year. Increased sales of natural gas, natural gas liquids, cement, clays, lead, lime, sand and gravel, and zinc more than offset losses in production and sales of coal, helium, and petroleum in the fuels segment and bentonite, gypsum, and stone in the minerals segments. Mineral fuels, dominant in the State's mineral industry, accounted for over 94 percent of total mineral value. Output of lead and zinc increased significantly with help of the lead and zinc mining stabilization program.

TABLE 1.—Mineral production in Oklahoma [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	737	$756	898	$911
Coal (bituminous) do.	1,048	6,978	1,008	5,667
Gypsum do.	509	1,668	531	1,462
Helium thousand cubic feet	284,214	9,917	237,201	8,302
Lead (recoverable content of ores, etc.) short tons	2,710	499	3,192	689
Natural gas million cubic feet	1,060,717	135,772	1,233,883	160,405
Natural gas liquids:				
Natural gasoline and cycle products thousand gallons	552,795	35,764	555,467	35,131
LP gases do.	838,903	25,223	810,894	28,981
Petroleum (crude) thousand 42-gallon barrels	202,732	591,977	[3] 200,238	[3] 582,693
Salt thousand short tons	5	25	4	26
Sand and gravel do.	4,436	4,736	5,420	6,116
Stone do.	14,666	18,819	13,817	16,160
Zinc (recoverable content of ores, etc.) short tons	10,013	2,303	13,245	3,046
Value of items that cannot be disclosed:				
Bentonite, cement, gem stones (1962), lime, pumice, and tripoli	----------	20,853	----------	22,929
Total	----------	[4] 855,290	----------	872,518

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producer).
[2] Excludes bentonite; included with "Value of items that cannot be disclosed."
[3] Preliminary figure.
[4] Revised figure.

[1] Geologist (mineral deposits), Bureau of Mines, Bartlesville, Okla.
[2] Geologist, Oklahoma Geological Survey, Norman, Okla.

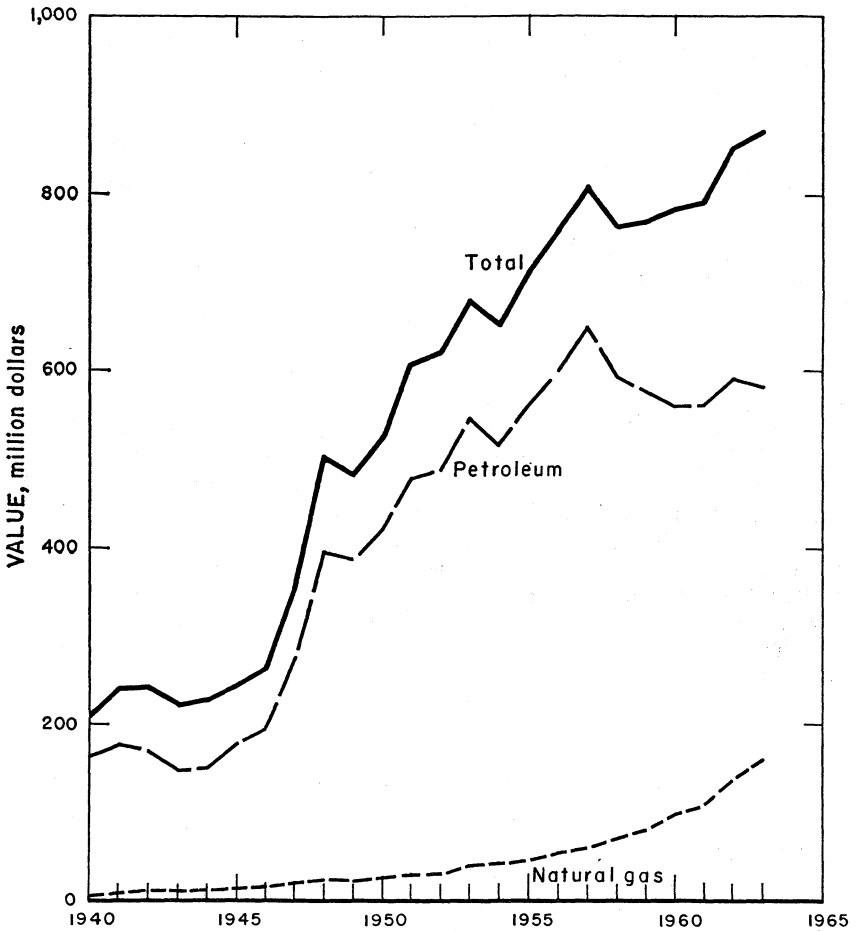


FIGURE 1.—Value of natural gas, petroleum, and total value of mineral production in Oklahoma, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Sixteen minerals—5 mineral fuels and 11 minerals—were produced in all counties in Oklahoma except Delaware County. Natural gas and petroleum were produced in 72 counties distributed in a wide belt extending from the northeastern to the southwestern and western sections of the State. Helium was recovered in Cimarron County. Nonmetals were produced in 60 counties in northeast, north-central, and central sections, and in the Arbuckle and Wichita Mountain regions of the southern section. Metal output was confined to Ottawa County.

TABLE 2.—Value of mineral production in constant 1957–59 dollars
(Thousands)

Year	Value	Year	Value
1952	$750,805	1958	$761,947
1953	770,015	1959	777,241
1954	711,733	1960	782,705
1955	774,723	1961	782,847
1956	815,864	1962	821,941
1957	802,537	1963	850,093

Employment and Wages.—Mineral industries in Oklahoma employed 42,400 persons, a decrease of over 3 percent from 1962, as employment continued to drop in various segments of the industries. As defined by the Oklahoma Employment Security Act, which covers establishments that employ 4 or more persons, the mineral industries paid $268 million in wages to 40,800 persons.

TABLE 3.—Annual average employment in the mineral industries

(Thousands)

Industry	1954–58 (average)	1959	1960	1961	1962	1963 [1]
Oil and gas drilling and production	47.78	45.0	42.6	42.5	41.5	40.4
Coal mining	1.14	.9	.7	.6	.5	.3
Other mining	2.12	1.8	1.8	1.9	1.9	1.7
Total	51.04	47.7	45.1	45.0	43.9	42.4

[1] Preliminary figures.

Source: Oklahoma Employment Security Commission, Handbook of Oklahoma Employment Statistics, 1939–63.

Consumption and Markets.—A significant portion of Oklahoma mineral output was processed into semifinished and finished products. Establishments involved were oil refineries; gasoline and cycle plants, which stripped condensable liquids from natural gas; a helium extraction plant; zinc smelters, which reduced zinc ore concentrate; cement, brick, tile, pottery, and glass plants, which used limestone, gypsum, clays, shales, and silica sands mined in Oklahoma; building products manufactured from gypsum mined in the State; and one producer of lime and calcium carbide manufactured from locally mined limestone. Large quantities of natural gasoline and petroleum products were transported by pipeline to industrial areas of the Eastern and North-Central States. Ammonia was produced from natural gas and carbon black from petroleum distillates.

Demand for Oklahoma crude petroleum was 642,000 barrels less than the previous year. Under State regulatory control, output was maintained in close balance with demand and stocks.

Outlay for new construction reached a record of nearly $1.5 billion, 13 percent above that of 1962. Preceded by a strong start during the first part of 1963, the peak of activity was reached in June, followed by an immediate decline rather than the usual normal high level maintained for several months. Residential construction reached its peak in June, then declined sharply; a new high of more than $1

billion—less than 1 percent above 1962—was established. Inasmuch as residential construction constituted almost 70 percent of all statewide construction, it was responsible for the overall slowdown. In other fields of construction, commercial building achieved the best record as more office and operating space was required by an expanding business community. The volume of $115 million was nearly 119 percent above that of 1962. Industrial building had one of its best years as its volume climbed over $18 million for a gain of 58 percent in 1963. Public utilities construction, up 30 percent, experienced its best year since 1958. Public works construction reached nearly $202 million, about 32 percent over that of 1962 and about equal to the record year in 1958; much of the gain resulted from a 73-percent increase in highway construction.

Trends and Developments.—Early in June, the State Legislature raised oil and gas depletion allowance in Oklahoma from 20 percent to 27.5 percent, effective in 1965. Increased exploration and production was expected to result from the depletion change.

The proved reserve of recoverable petroleum declined in 1963 and, at yearend, was estimated at 1,628 million barrels, a 6-percent drop from the previous year. No significant petroleum reserves were found to offset production. The natural gas reserve was increased 5 percent in 1963.

Exploration and development well drilling was widespread in 1963, although the total number of wells drilled was almost 14 percent below that of the previous year. A total of 416 exploratory wells was drilled; 53 were oil, 37 gas, and 326 dry. In new discoveries, Garfield and McClain Counties had eight each; Cleveland, Ellis, Texas, and Woodward Counties had five each.

Significant deep drilling below 11,000 feet resulted in several impressive new-pool discoveries. The most impressive was the Tenneco No. 1 Hill in McClain County where a triple completion at 11,302 feet in Viola limestone and first and second Bromide sandstones resulted in initial production of 989 barrels of oil and 1,430 thousand cubic feet of gas per day. Perhaps the most significant new-pool discovery, South Alex field in southeastern part of the Anadarko basin, was the Humble Oil & Refining Company's No. 1 Thomason in Grady County. Drilled to 16,530 feet, the well was plugged back to 16,483 feet and produced from three sandstones in the Bromide formation. Calculated open-flow production was at the rate of 18,840 thousand cubic feet of gas per day plus 6.204 barrels of oil per day. Discovery of Arbuckle production in McClain County by Goff Oil Co. at the No. 2–A Dempsey-Mantooth resulted in a triple completion below 10,000 feet producing from Simpson sandstones and Arbuckle dolomite of 140 barrels of oil and 160 barrels of condensate per day, and 4,738 thousand cubic feet of gas per day.

Sinclair Oil & Gas Co. discovered a new gas pool in a Springer sandstone in the densely drilled Doyle field area of northern Stephens County. The well, No. 1 Oakman Unit had a calculated open-flow potential of 20,800 thousand cubic feet of plus 19 barrels of condensate per day at a depth of 6,270 feet.

Fireflooding was initiated by two companies to recover additional petroleum. Continuental Oil Co. planned to fireflood 80 acres in the

Loco sands of Loco field in Stephens County; the project would involve 15 producing wells and 8 injection wells. Sinclair Oil & Gas Co., on less than a 10-acre site on the Avant pool of Osage County, planned to use four wells as producing wells and one injection well; this test, in the Bartlesville sand, would be evaluated in 3 years. Some 15,300 acres of the Manning formation in Major County's Ringwood field were unitized for secondary recovery through waterflooding by Livingston Oil Co. in an effort to recover between 9 million and 20 million barrels of oil. The project was the first attempted in the Manning which lies about 6,900 feet below the surface.

A $3 million engineering and physical sciences building at the Federal Bureau of Mines Petroleum Research Center in Bartlesville was dedicated on April 9.

Sinclair Research, Inc., dedicated its new $4 million exploration and research center in Tulsa.

John Deere Chemical Co. completed a $3 million expansion program to boost ammonia output at Pryor. In August, the company announced plans for another multimillion dollar expansion program, which, when completed by mid-1964, would double the plant's urea capacity.

Sunray DX Oil Co. began construction in September of a $3.4 million solvent extraction unit at its Tulsa refinery. When completed about September 1964, the plant would replace several smaller ones and would have a 500-barrel-per-day capacity. The lube unit is the last in the company's 6-year $30 million modernization program at the Tulsa refinery.

Sandlin Oil & Refining Co. purchased the Wilcox Oil Co.'s Bristow refinery and its Depew-to-Cushing pipeline in September.

Dewey Portland Cement Co., a division of Martin-Marietta Corp., announced in October that the plant at Dewey would close November 1; work would be shifted to the Tulsa plant, which was undergoing an expansion to double its present capacity. Earlier in the year, the company moved its headquarters from Kansas City to Tulsa.

Southwestern Gypsum Co. ceased production of gypsum for agricultural use near Weatherford. A new company, Republic Gypsum Co., Lubbock, Tex., began constructing a $4 million wallboard plant at Duke in Jackson County. Crude gypsum, mined from a shallow deposit south of the plant, will be processed.

Armco Steel Corp. of Middletown, Ohio, announced in November that the largest continuous steel-casting unit in the Nation would be constructed at the Sand Springs works of the Sheffield Division. Completion was scheduled for late 1964.

The U.S. Army Corps of Engineers, Tulsa District, continued construction on two major reservoir projects—Eufaula Dam on the South Canadian River between Haskell and McIntosh Counties and Keystone Dam on the Arkansas River in Tulsa County. Oologah Dam on the Verdigris River in Rogers County was completed; dedication ceremonies were held at the dam on July 20.

Grand River Dam Authority was constructing Markham Ferry Dam project on the Grand River in Mayes County.

Water.—Water problems including long-range supply, quality, pollution, reuse, and treatment received increasing attention from Federal

and State agencies, and private research institutions. The Federal Bureau of Mines conducted a nationwide canvass of the mineral industry in 1963 to obtain 1962 water use data. The following tables are based on the results of the survey.

TABLE 4.—Water use in the mineral industry in 1962

(Million gallons)

	New water	Water recirculated	Total water use	Water discharged	Water consumed
Quarries and mills	300	348	648	289	11
Coal (bituminous)	26	132	158	15	11
Metal mines and mills	38	816	854	32	6
Nonmetal mines and mills	2		2	2	
Sand and gravel mines	4,874	9,215	14,089	4,781	93
Natural gas processing plants	3,362	171,121	174,483	1,093	2,269
Petroleum	22,725	24,776	47,501	417	22,308
Total	31,327	206,408	237,735	6,629	24,698

TABLE 5.—Water usage of wells drilled by rotary tools, by county, in 1962

(Barrels)

County	Number of wells	Total footage	Fresh water used	Saline water used	Total barrels/foot
Alfalfa	25	133,813	194,400		1.45
Atoka	13	31,357	27,850		.89
Beaver	271	1,996,188	3,059,569		1.53
Beckham	18	65,308	114,300		1.75
Blaine	23	210,510	875,700		4.16
Bryan	10	71,444	383,200		5.36
Caddo	29	92,155	128,850		1.40
Canadian	10	99,163	555,800		5.60
Carter	213	623,175	868,679		1.39
Cimarron	24	110,470	186,500		1.69
Cleveland	67	513,945	1,275,000		2.48
Coal	12	63,730	63,700		1.00
Comanche	35	65,753	123,500		1.88
Cotton	64	141,980	249,500		1.76
Creek	310	680,881	488,995		.72
Custer	14	140,226	294,800		2.10
Dewey	60	593,755	2,191,950		3.69
Ellis	46	409,109	1,591,600		3.89
Garfield	101	517,465	1,775,250		3.43
Garvin	123	618,300	3,177,167		5.14
Grady	28	174,054	642,400		3.69
Grant	69	346,497	521,700		1.51
Greer	10	18,788	37,500		2.00
Harper	58	376,604	666,846		1.77
Haskell	19	123,797	621,300		5.02
Hughes	87	220,913	87,100		.39
Jackson	1	4,450	10,000		2.25
Jefferson	45	95,785	238,600		2.49
Kay	133	447,742	241,425		.54
Kingfisher	367	2,592,752	8,664,720		3.34
Kiowa	35	37,570	37,500		1.00
Latimer	28	285,066	1,182,604		4.15
Le Flore	12	93,778	363,800		3.88
Lincoln	131	512,501	194,620		.38
Logan	34	176,679	176,700		1.00
Love	20	155,552	1,348,200		8.67
McClain	97	856,265	6,381,000		7.45
McIntosh	13	45,149	45,200		1.00
Major	101	748,764	1,102,500		1.47
Marshall	35	59,080	98,100		1.66
Murray	35	108,850	161,910		1.49
Muskogee	189	287,771	287,000		1.00
Noble	62	267,939	147,300		.55
Nowata	10	30,000		20,000	.67
Okfuskee	98	302,961	121,000		.40
Oklahoma	22	123,341	314,500		2.55

TABLE 5.—Water usage of wells drilled by rotary tools, by county, in 1962—Con.

(Barrels)

County	Number of wells	Total footage	Fresh water used	Saline water used	Total barrels/foot
Okmulgee	177	334,660	200,000		.60
Osage	370	782,323	1,438,725		1.84
Pawnee	45	138,559	192,350		1.39
Payne	46	174,719	124,770		.71
Pittsburg	9	58,040	197,300		3.40
Pontotoc	59	144,250	149,400		1.04
Pottawatomie	83	392,423	130,300		.33
Pushmataha	2	10,125	15,000		1.48
Roger Mills	1	17,588	35,000		1.99
Rogers	3	1,200	3,000		2.50
Seminole	147	424,283	124,000		.29
Sequoyah	1	6,146	15,365		2.50
Stephens	151	361,275	939,765		2.60
Texas	146	875,288	1,384,040		1.58
Tillman	8	25,486	28,000		1.10
Washington	243	249,133	75,200		.30
Washita	3	35,187	377,800		10.74
Woods	33	195,839	274,500		1.40
Woodward	26	215,177	257,450		1.20
Various	2	11,840	8,880		.75
Total	4,762	20,124,916	47,290,680	20,000	2.35

TABLE 6.—Water usage of wells drilled by rotary tools, by county, in 1962

(Barrels)

County	Number of wells	Total footage	Fresh water used	Saline water used	Total barrels/foot
Adair	1	1,596	800		0.50
Cherokee	2	3,504	1,750		.50
Craig	5	1,237	600		.49
McCurtain	1	1,400	700		.50
Nowata	112	49,498	3,000	18,260	.43
Okmulgee	8	14,962	14,000	100	.94
Osage	2	2,200	3,000		1.36
Rogers	122	61,177	18,000	290	.30
Tulsa	103	149,989	75,000		.50
Wagoner	70	66,315	33,000		.50
Washington	16	16,456	4,430	2,000	.39
Total	442	368,334	154,280	20,650	.47

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Oklahoma continued to be an important source of natural gas and crude petroleum and furnished a major supply of refined products. Low-ash bituminous coal was produced, although output was below that of the previous year.

Prices on nearly 60 percent of the State's oil production were lowered 5 cents per barrel to $3 for sweet crude and $2.95 for sour early in February. Balance of the output was sold at $3.05 and $3, respectively. In May, several companies restored the 5-cent cut but used a new gravity scale which reduced the price of oil by 2 cents per degree for each degree for oil below 40 gravity down to 36 gravity and by 4 cents per degree for oil below 36 gravity. In October, some firms again posted a 5-cent-per-barrel cut to $3 for sweet crude of 40 to 44.9 gravity and a price escalation per degree below 40 gravity.

Wholesale prices of liquefied petroleum gas were increased in 0.5-cent-per-gallon increments on September 1 and again on November 15 by one major firm.

Carbon Black.—Output of carbon black decreased 11 percent in quantity and 9 percent in value in 1963 and was produced from petroleum distillate by Continental Oil Co. at its Ponca City refinery.

Coal (Bituminous).—Low-ash bituminous coal output decreased 4 percent. Slightly more than 1 million tons valued at nearly $5.7 million was produced by 14 operators at 15 mines (4 underground and 11 strip) in 7 counties. Haskell, Rogers, and Craig Counties led in value of output. Sixteen other producers, who mined less than 1,000 tons each, were active in Craig, Haskell, Latimer, Le Flore, Muskogee, Okmulgee, and Pittsburg Counties. On July 30, Lone Star Steel Co. closed its Carbon No. 5 mine near Hartshorne; on September 9, the company announced the mine was closed because of structural conditions in the roof and uneconomic operating costs.

TABLE 7.—Coal (bituminous) production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954-58 (average)	1,982	$12,259	1961	1,032	$6,784
1959	1,525	10,272	1962	1,048	6,978
1960	1,342	9,113	1963	1,008	5,667

Helium.—The Federal Bureau of Mines plant at Keyes extracted 300 million cubic feet of helium from natural gas, an increase of 3 percent over that of 1962. Sales to Government and commercial users totaled 237 million cubic feet valued at $8.3 million. The Atomic Energy Commission and the Department of Defense remained the principal purchasers and accounted for almost 87 percent of the demand; civilian purchasers comprised the balance. Helium was used in research and in missile and space programs.

Natural Gas.—Oklahoma continued to be the third largest gas-producing State as 64 counties, led by Texas, Beaver, Harper, Beckham, Garvin, Stephens, McClain, Kingfisher, Major, and Grady Counties, in descending order, reported natural gas output.

Development well drilling accounted for 393 gas discoveries and exploratory drilling for 37 gas wells. Estimated proved recoverable natural gas reserves increased 4 percent to 19,139 billion cubic feet at yearend. Exploratory drilling added 382 billion cubic feet through new discoveries; extensions and revisions added another 1,621 billion cubic feet to the gas reserves, according to the American Gas Association.

TABLE 8.—Marketed production of natural gas[1]

Year	Million cubic feet	Value (thousands)	Year	Million cubic feet	Value (thousands)
1954-58 (average)	665,246	$54,606	1961	892,697	$108,016
1959	811,508	81,151	1962	1,060,717	135,772
1960	824,266	98,088	1963	1,233,883	160,405

[1] Comprises gas either sold or consumed by producers, including losses in transmission, amounts added to storage, and increases in gas pipelines.

TABLE 9.—Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

	Proved reserves, Dec. 31, 1962	Changes in proved reserves, due to extensions and new discoveries in 1963	Proved reserves, Dec. 31, 1963 (production was deducted)	Changes from 1962, percent
Crude oil—thousand 42-gallon barrels	1,728,268	94,367	1,628,138	−6
Natural gas liquids [1]—do	347,003	6,962	328,193	−5
Natural gas—million cubic feet	[2] 18,259,036	2,002,995	19,138,820	+5

[1] Includes condensate, natural gasoline, and LP gases.
[2] Revised figure.

Source: American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas: V. 18, Dec. 31, 1963, pp. 11, 12, 21.

TABLE 10.—Oil and gas wells drilled in 1963, by counties

County	Proved field wells				Exploratory wells			Total
	Oil [1]	Gas	Service	Dry	Oil [1]	Gas	Dry	
Adair							1	1
Alfalfa	3	3		4			3	13
Atoka	5			3			3	11
Beaver	86	37	1	37		2	3	166
Beckham	3	1	1	1	1		3	10
Blaine	1	12		4			5	22
Bryan	1			4			4	9
Caddo	16			5	1		3	25
Canadian	3	4					2	9
Carter	143	5	11	54			8	221
Cimarron	10	8		10		1	4	33
Cleveland	12		2	14	5		17	50
Coal		6		2			10	18
Comanche	12	4	1	15		1	2	35
Cotton	17		11	7			5	40
Craig	1		5	5	2		1	14
Creek	115	2	60	27			2	206
Custer	10	3		3				16
Dewey	33	22		13	1	2	2	73
Ellis	6	8		15	1	4	3	37
Garfield	151	12	11	19	8		13	214
Garvin	72	7	3	33	1		13	129
Grady	1	3	2	1		1	3	11
Grant	17	6	2	18	3	1	5	52
Greer	1	1		1			1	4
Harmon							1	1
Harper	4	11		10		1	3	29
Haskell	1	15		5		2	5	28
Hughes	23	27	2	8	1	2	5	68
Jackson	2			1	1		2	6
Jefferson	28		4	13	1		13	59
Johnston							1	1
Kay	27	1	3	25			14	70
Kingfisher	137	14		8	3		2	164
Kiowa	8	2		18			4	32
Latimer		23		2			1	26
Le Flore		7		4		4	4	19
Lincoln	38	9	6	27	1	1	10	92
Logan	10			6	3	1	10	30
Love	17	3		9	1		3	33
Major	27	15		8	1	1	2	54
Marshall	10	2		9			2	23
Mayes						1	1	2
McClain	25	7	1	6	8		5	52
McCurtain							2	2
McIntosh		1		1			1	3
Murray	16			14	1		14	45
Muskogee	52	1	20	15			1	89
Noble	15	1	2	11			4	33
Nowata	41		25	15				81
Okfuskee	30	9	6	19	1		4	69
Oklahoma	5	1		8			4	18
Okmulgee	121	2	11	31			2	167

See footnote at end of table.

TABLE 10.—Oil and gas wells drilled in 1963, by counties—Continued

County	Proved field wells				Exploratory wells			Total
	Oil [1]	Gas	Service	Dry	Oil [1]	Gas	Dry	
Osage	145		117	61	1		18	342
Pawnee	18		14	7			5	44
Payne	25	2	3	16			4	50
Pittsburg		13		4		3	6	26
Pontotoc	61	1	3	21	1	1	4	92
Pottawatomie	32		5	15			9	61
Roger Mills					1			1
Rogers	57		52	16				125
Seminole	105	3	21	37		1	11	178
Sequoyah		1		2				3
Stephens	88	5	23	38			6	160
Texas	81	47	1	38	3	2	9	181
Tillman	5			1				6
Tulsa	50	3	22	18	1			94
Wagoner	27	1	2	43				73
Washington	163		76	21	1			261
Washita				1				1
Woods	1	13		13			14	41
Woodward	6	9		14		5	4	38
Total: 1963	2,220	393	529	934	53	37	326	4,492
1962	2,613	432	647	1,078	87	45	301	5,203

[1] Includes distillate wells.

Source: Oil and Gas Journal. V. 62, No. 4, Jan. 27, 1964, pp. 187, 189, 191.

Seven gas storage fields were in use by the natural gas industry in eight counties. Cities Service Gas Co., late in the year, began to develop an underground gas storage field in Webb field in Grant County with service scheduled for 1964. The company planned to clean out and plug old wells and drill about 40 new wells for injection and withdrawal of gas. Underground storage facilities had a total capacity of 158.1 billion cubic feet of working gas volume (above minimum working pressure) and 125.1 billion cubic feet of cushion gas volume (below minimum working pressure). Available storage capacity permitted continuous production and conservation of casinghead gas from oil wells during periods of low demand.

Natural Gas Liquids.—Recovery of natural gas liquids by 74 natural gasoline plants and 4 cycling plants totaled about 1.4 billion gallons and represented a 2-percent decrease as compared with that of 1962. Natural gasoline and cycle products represented 41 percent of the quantity and 55 percent of the value in 1963; LP gases accounted for the remainder.

TABLE 11.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1954-58 (average)	474,937	$26,201	557,897	$19,775	1,032,834	$45,976
1959	448,353	29,443	675,869	27,070	1,124,222	56,513
1960	531,995	33,074	762,258	32,409	1,294,253	65,483
1961	521,237	33,358	817,082	30,141	1,338,319	63,499
1962	552,795	35,764	838,903	25,223	1,391,698	60,987
1963	555,467	35,131	810,894	28,981	1,366,361	64,112

Pan American Petroleum Corp., 1 of 40 owners, began operating a 50-million-cubic-foot-per-day refrigeration absorption plant 2 miles east of Mooreland. Colorado Interstate Gas Co. placed on stream its 50-million-cubic-foot-per-day refrigeration absorption plant at Keyes. Sinclair Oil & Gas Co. completed its 10-million-cubic-foot-per-day refrigeration absorption plant near Healdton. In December, Livingston Oil Co. completed its 20-million-cubic-foot-per-day refrigeration absorption plant at Enid. Pan American Petroleum Corp. also activated its 30-million-cubic-foot-per-day refrigeration absorption plant at Okeene. Four gasoline plants, with an estimated processing capacity totaling 95 million cubic feet per day, were under construction. The plants were: Champlin Oil & Refining Co., 40-million-cubic-foot-per-day refrigeration absorption plant northeast of Enid, Garfield County; Cities Service Oil Co., 35-million-cubic-foot-per-day refrigeration plant west of Hooker, Texas County; Humble Oil & Refining Co., a 15-million-cubic-foot-per-day refrigeration absorption plant near Camargo, Dewey County; and Mobil Oil Co., a 4.5-million-cubic-foot-per-day refrigeration plant in Dewey County. Chapman gasoline plant in Hughes County and Kerr-McGee Oil Industries, Inc., Laffoon plant in Okfuskee County were shut down during the year.

According to American Gas Association, the proved recoverable reserve of natural gas liquids in Oklahoma at yearend was estimated at 328.2 million 42-gallon barrels—4 percent of the U.S. total. Exploratory drilling added nearly 6 million barrels to the recoverable reserve; development drilling added 1.2 million barrels through extensions and revisions as compared with 34.3 million barrels in 1962.

Underground storage capacity for natural gas liquids was 925,000 barrels at seven sites, according to the Oil and Gas Journal. Warren Petroleum Corp. increased capacity from 35,000 to 140,000 barrels of LP gas at its Beaver County salt formation storage. Continental Oil Co.'s 200,000-barrel propane storage in a Grant County salt formation was under construction at yearend.

Petroleum.—Crude oil production totaled 200.2 million barrels from 81,475 oil wells, compared with 202.7 million barrels from 80,799 oil wells in 1962. Daily average production of crude oil was 548,600 barrels, or nearly 6.7 barrels per well. Average indicated daily demand for crude oil was over 550,100 barrels, slightly less than the 551,900 barrels in 1962.

TABLE 12.—Crude petroleum production

(Thousand 42-gallon barrels and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954–58 (average)	203,978	$585,388	1961	193,081	$561,866
1959	198,090	578,423	1962	202,732	591,977
1960	192,913	563,306	1963 [1]	200,238	582,693

[1] Preliminary figures.

Estimated proved recoverable reserves of crude oil amounted to 1,628.1 million barrels as of December 31, 1963, according to the American Petroleum Institute, a decrease of 100.1 million barrels from December 31, 1962. The reserve was equivalent to over 8.1 barrels of recoverable crude oil underground for each barrel of oil produced in 1963. Extensions and revisions added 89.8 million barrels to the

proved reserve and new discoveries added 4.6 million barrels. Oklahoma had 5 percent of the total U.S. oil reserve and 7 percent of total liquid fuel reserves, including natural gas liquids.

TABLE 13.—Crude petroleum production, indicated demand, and stocks, in 1963, by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Oklahoma	Month	Production	Indicated demand	Stocks originating in Oklahoma
January	16,718	17,471	18,334	September	16,086	16,059	16,827
February	15,668	15,677	18,325	October	16,786	16,017	17,596
March	17,399	18,575	17,149	November	16,289	16,195	17,690
April	16,943	16,506	17,586	December	16,788	15,956	18,522
May	17,184	16,986	17,784				
June	16,544	16,891	17,437	Total: 1963 [1]	200,238	200,803	----------
July	16,936	17,482	16,891	1962	202,732	201,445	----------
August	16,897	16,988	16,800				

[1] Preliminary figures.

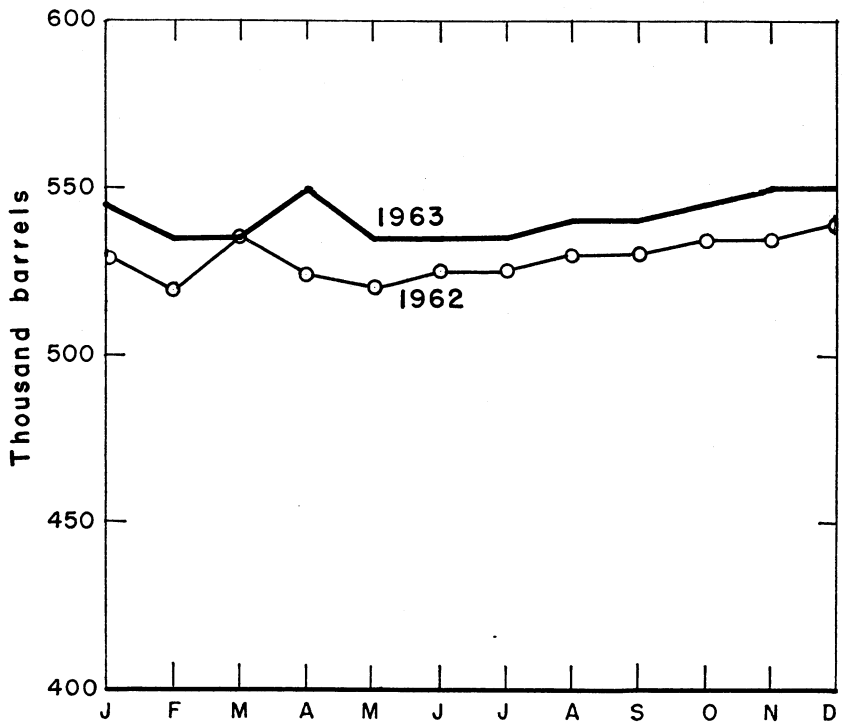


FIGURE 2.—Petroleum allowable production in thousand barrels per day established by the Oklahoma Corporation Commission, by months.

The Oklahoma Corporation Commission, in a move to encourage wider spacing of shallow wells and eliminate unnecessary drilling, revised the basic formula for oil well production allowables. The revision gave larger allowable increments to 20- and 40-acre wells less than 5,000 feet in depth; for wells drilled on patterns of 10 acres or less, the basic formula was unchanged.

Petroleum production was reported in 67 counties of which Osage, Stephens, Carter, Garvin, Kingfisher, and Creek Counties led in order named. Unallocated fields, including secondary recovery projects and stripper wells, accounted for 59 percent of total output.

TABLE 14.—Production of crude petroleum, by fields

(Thousand 42-gallon barrels)

Field [1]	1959	1960	1961	1962	1963 [2]
Allen	1,676	1,525	1,403	1,390	1,445
Atlantic	1,047	1,111	1,171	1,462	1,450
Bradley	2,898	2,631	3,048	3,273	([3])
Burbank	14,463	15,676	15,275	14,290	13,685
Cement	4,222	3,836	4,038	3,533	3,340
Cumberland	1,407	1,219	1,213	1,142	1,133
Cushing	2,585	2,515	2,537	2,629	2,828
Dover-Hennessey			4,841	8,945	9,010
Doyle	2,241	1,798	1,671	1,313	1,219
Edmond-West	1,013	1,407	1,212	1,179	1,150
Eola-Robberson	3,863	3,470	3,624	3,444	3,384
Glenn Pool	3,164	3,200	3,368	3,490	3,303
Golden Trend	10,627	11,071	10,202	10,730	13,427
Healdton	2,256	2,154	2,353	2,513	2,506
Hewitt	2,977	2,938	2,989	2,550	2,461
Holdenville-East	412			1,210	1,100
Joiner City	395	1,561	2,054	1,980	2,296
Lincoln			424	1,395	1,494
Loco	1,290	1,309	1,517	1,738	1,848
Naval Reserve	1,667	2,353	2,456	2,367	2,170
Oklahoma City	3,050	2,851	2,617	2,381	2,300
Payson	423	893	[4] 1,421	2,005	1,308
Seminole:					
Bowlegs	665	905	1,125	1,240	1,110
St. Louis	1,379	1,422	1,449	1,440	1,535
Sho-Vel-Tum	25,175	24,227	24,510	24,350	24,995
Other fields	109,195	102,841	96,563	100,743	99,741
Total	198,090	192,913	193,081	202,732	200,238

[1] Based on Oil and Gas Journal data adjusted to Bureau of Mines total.
[2] Preliminary figures.
[3] Consolidated into Golden Trend.
[4] Revised figures.

Interstate Oil Compact Commission in cooperation with National Stripper Well Association reported that, on January 1, Oklahoma had 68,722 stripper wells which produced almost 115 million barrels of oil in 1962. Oil reserves of stripper wells totaled slightly more than 1 billion barrels, or 60 percent of overall proved oil reserves in Oklahoma on January 1.

Average price per barrel of crude petroleum at the wellhead was $2.91—1 cent less than in 1962.

Thirteen Oklahoma refineries had a total daily operating capacity of 411,580 barrels of crude oil and 146,930 barrels of cracked gasoline on January 1, 1963. The refineries processed about 68 percent of the State production in 1963. Crude oil runs to stills, total receipts, intrastate receipts, and yearend stocks at Oklahoma refineries for 1962 and 1963, in thousand barrels, were as follows:

Year	Runs to stills	Total receipts	Intrastate receipts	Stocks Dec. 31
1962	133, 387	133, 331	102, 072	1, 981
1963	135, 568	135, 799	102, 110	2, 262

Pipelines.—Arkoma Basin's only major natural gas transmission line was completed by Arkansas Louisiana Gas Co. near yearend. The pipeline extends from Centrahoma field in Coal County northeastward through Pittsburg, Latimer, Haskell, and Le Flore Counties to the company's existing pipeline near Paris, Ark. Compressor stations are located at Wilburton and Spiro; gathering systems connect the Red Oak, Wilburton, Carterville, Milton, Savanna, and Ashland fields with the main 24-inch trunkline. In December, the company announced plans to more than double capacity of the new line.

A 19,200-barrel-per-day, 95-mile liquefied petroleum gas pipeline from Hennessey to Ponca City via Medford and Blackwell was completed in early December by Cherokee Pipeline Co. Pump stations were under construction and due to be completed early in 1964. The line will carry propane, butane, and natural gasoline to Ponca City from natural gas processing plants near Hennessey, Medford, and Blackwell. Propane and butane will be stored in underground caverns at Medford and Ponca City for peak demand periods.

Late in the year, Cameron Crude Oil Corp. announced plans to construct a 200-mile pipeline, consisting of 110 miles of 8-inch pipe and 90 miles of 3- and 4-inch lateral lines, from South Balko field in Beaver County to the Shell Oil Co. pipeline at Elk City. Crude oil capacity of the line will be 8,000 barrels per day.

Mid-Continent Pipe Line Co. completed a 34-mile, 12-inch crude oil line from Drumright to the Sunray DX Oil Co. Tulsa refinery. The new line replaced a smaller line and more than doubled pipeline capacity to the refinery.

Western Farmers Cooperative, an electric cooperative association, planned construction of a natural gas pipeline from Northeast Trail field in Dewey County to Mooreland in Woodward County where the cooperative will construct a 55,000-kilowatt electric-generating plant. Gas purchased by the association at the wellhead will be used for fuel. When completed, the plant will supplement the present system which includes 12 generating plants.

NONMETALS

Nine nonmetals produced in 1963 were valued at $47.6 million, about 6 percent of the State's total mineral production value. Cement, clays, and sand and gravel increased in quantity and value compared with 1962. Gypsum output increased in quantity but decreased in value; stone production decreased in both quantity and value.

Cement.—Shipments of cement by three companies at four locations increased 15 percent; value rose 11 percent over that of 1962. Dewey Portland Cement Co., a division of Martin-Marietta Corp., was doubling capacity of its Rogers County plant near Tulsa. Late in October, the firm announced that its Dewey, Washington County, plant would close on November 1 and work would be transferred to the Tulsa operation. Plants at Ada in Pontotoc County, Pryor in Mayes

County, and near Tulsa in Rogers County were active throughout the year.

TABLE 15.—Shipments of portland cement to Oklahoma consumers

Year	Thousand barrels	Change, percent	
		In Oklahoma	In United States
1954–58 (average)	4,797		
1959	5,374	+5	+9
1960	4,669	−13	−7
1961	5,573	+19	+3
1962	5,941	+7	+3
1963	7,105	+20	+5

Clays.—Quantity and value of clay sold or used in 1963 increased 22 percent and 21 percent, respectively. Clay produced in 1963 was used primarily to manufacture brick and tile and, to a lesser extent, for portland cement and expanded clay products. Brick and tile were produced in Creek, Custer, Garfield, Greer, Lincoln, Oklahoma, Pittsburg, Pontotoc, Seminole, and Tulsa Counties; expanded clay aggregate was produced in Tulsa and Oklahoma Counties; and pottery was manufactured in Creek County. Bentonite was mined in Dewey County for filtering and absorbent uses.

TABLE 16.—Clays sold or used by producers[1]

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954–58 (average)	619	$779	1961	792	$801
1959	966	970	1962	737	756
1960	734	739	1963	898	911

[1] Excludes bentonite.

Gypsum.—Output of crude gypsum increased 4 percent but value dropped 12 percent. U.S. Gypsum Co., a major producer, operated several quarries and a plant at Southard, Blaine County, to manufacture wallboard and other plaster products. Texas Gypsum Co. began open-pit operations east of Fletcher, Comanche County, in the Cloud Chief formation; the gypsum was used in manufacturing wallboard at its Irving, Tex., plant. Republic Gypsum Co. was constructing a $4 million wallboard plant at Duke, Jackson County. The Van Vacter member of the Blaine formation will be mined at a quarry about 1½ miles south of the new plant. Gypsum was produced by other operators in Blaine, Caddo, Canadian, and Washita Counties for agricultural use and as a retarder in portland cement.

Lime.—St. Clair Lime Co. produced lime in Sequoyah County from locally mined limestone; output increased slightly. The lime was used mostly by chemical plants in Pryor and by municipal water plants.

Pumice.—Output of pumice decreased 4 percent but value was the same as that of the previous year. Principal use was for abrasive-type cleaners.

Salt.—Salt was produced in Harmon County by solar evaporation of brine from springs and in Woods County from surface encrustations on the Big Salt Plain of the Cimarron River. Principal uses were for stockfeed and recharging of water softeners; other uses included herbicides and salinity control of oil well drilling fluid.

Sand and Gravel.—Johnston, Logan, McClain, Muskogee, Oklahoma, Pushmataha, and Tulsa Counties furnished 62 percent of the quantity and 70 percent of the value of sand and gravel produced in 35 counties during 1963. Trucks transported 81 percent of sand and gravel shipped by commercial producers and the remaining 19 percent was hauled by rail. Sand was used principally as building, paving, and fill; high-purity sand was used in glassmaking. Gravel was used mostly for paving and building.

TABLE 17.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total sand and gravel	
	Quantity	Value	Quantity	Value	Quantity	Value
1954-58 (average)	3,565	$3,802	2,406	$1,050	5,971	$4,852
1959	4,376	4,988	1,626	939	6,002	5,927
1960	4,823	6,544	1,601	924	6,424	7,468
1961	4,029	4,515	1,281	998	5,310	5,513
1962	3,802	4,355	634	381	4,436	4,736
1963	4,644	5,756	776	360	5,420	6,116

Stone.—Comanche, Kiowa, Murray, Pontotoc, and Tulsa Counties supplied 59 percent of all stone produced in the State and 61 percent of the value. Limestone comprised 90 percent of the total stone produced. Sandstone accounted for 1 percent; granite and chat comprised 9 percent. Most of the stone was crushed and used for roadstone, concrete aggregate, and manufacture of cement and lime. Except for limestone at two underground mines in eastern Oklahoma, all stone was produced by open-pit methods. Trucks carried 43 percent of the crushed limestone shipments; railroads 5 percent; and unspecified transportation, 52 percent.

Chat.—The coarse tailing from milling lead and zinc ores in the Tri-State District, chat, is essentially chert with small quantities of limestone, galena, sphalerite, marcasite, and pyrite. Most of the chat was sold for railroad ballast, concrete aggregate, and road surfacing.

Granite.—Four producers operated six quarries in the Wichita Mountain area of Greer and Kiowa Counties, center of the State dimension-granite industry. Two producers operated in Johnston County. The stone was predominantly pink and red granite. Most of the dimension granite used for monumental stone was finished in plants within the area; some rough blocks were shipped to other states for finishing.

Limestone and Dolomite.—Limestone and dolomite were quarried in 36 counties; Comanche, Murray, and Tulsa Counties reported the greatest output. Chemical-grade limestone was quarried at Marble City, Sequoyah County, for use as a flux in glassmaking, for manufacturing lime, and for agricultural purposes. Dimension limestone was quarried in Caddo, Jackson, Johnston, and Pontotoc Counties for building stone, curbing, and flagging. Limestone for manufacturing

TABLE 18.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	1,667	$1,420	2,067	$1,953
Paving	870	749	1,053	977
Fill	486	220	533	316
Other [1]	347	1,442	528	1,945
Total	3,370	3,831	4,181	5,191
Gravel:				
Building	116	179	259	378
Paving	310	338	176	146
Other [2]	6	7	28	41
Total	432	524	463	565
Total sand and gravel	3,802	4,355	4,644	5,756
Government-and-contractor operations:				
Sand:				
Building			1	2
Paving	391	186	250	118
Other [3]			5	2
Total	391	186	256	122
Gravel:				
Building			14	15
Paving	241	194	506	223
Fill	2	1		
Total	243	195	520	238
Total sand and gravel	634	381	776	360
Grand total	4,436	4,736	5,420	6,116

[1] Includes other construction sand and industrial sand (unground and ground).
[2] Includes miscellaneous gravel and other construction gravel, fill (1963).
[3] Other construction sands.

TABLE 19.—Sand and gravel production in 1963, by counties

County	Short tons	Value	County	Short tons	Value
Alfalfa	20,351	$16,059	Oklahoma	387,783	$486,155
Atoka	47,723	16,089	Pawnee	39,734	23,840
Carter	9,800	11,000	Pottawatomie	29,736	23,857
Choctaw	25,603	10,241	Seminole	21,260	27,638
Cleveland	156,596	62,639	Texas	8,775	9,750
Cotton	82,084	119,800	Tillman	15,062	6,278
Dewey	2,500	2,500	Tulsa	1,222,903	848,588
Garvin	4,430	6,480	Woodward	29,411	30,509
Greer	129,500	81,610	Other counties [1]	2,956,235	4,169,163
Kiowa	200,000	148,000	Total	5,420,000	6,116,000
Le Flore	26,514	10,604			
Okfuskee	4,000	5,200			

[1] Includes Bryan, Caddo, Grady, Jackson, Johnston, Kay, Kingfisher, Logan, McClain, McIntosh, Major, Murray, Muskogee, Pontotoc, and Pushmataha Counties, combined to avoid disclosing individual company confidential data. Undistributed amounts from various counties are also included.

portland and masonry cement was quarried in Mayes, Pontotoc, Rogers, and Washington Counties. Dolomite was quarried in Johnston County for flux in glass manufacturing and as soil conditioner.

Sandstone.—Output of sandstone, quarried in seven counties, was 87 percent below that of the previous year; the decline was due largely to completion of projects by the U.S. Army Corps of Engineers,

TABLE 20.—Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Granite		Limestone		Sandstone		Other stone		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1959	[1] 5	$720	11,242	$13,455	222	$241	1,214	$564	12,683	$14,980
1960	[2] 5	620	11,995	13,852	784	870	1,270	756	[2] 14,054	[2] 16,098
1961	22	681	12,531	13,712	1,133	1,529	1,295	639	14,981	16,561
1962	15	1,043	12,579	15,793	1,040	1,351	1,032	632	14,666	18,819
1963	7	832	12,437	14,537	135	214	1,238	577	13,817	16,160

[1] Crushed granite included with "Other stone."
[2] Excludes crushed granite.

Tulsa District. Crushed sandstone was also used by the Oklahoma State Highway Department.

Tripoli.—Tripoli output in eastern Ottawa County increased 13 percent. The crude material was processed at Seneca, Mo., by American Tripoli Division of The Carborundum Co. and sold primarily for buffing compounds and in minor quantities for foundry use.

Vermiculite.—Crude vermiculite produced in other States was exfoliated by Texas Vermiculite Co. at its Oklahoma City plant. The amount of exfoliated vermiculite sold or used, increased 66 percent.

Water.—Two multimillion dollar reservoir projects, under construction by U.S. Army Corps of Engineers, Tulsa District, were part of the system of locks and dams on the Arkansas River to make the river navigable. Eufaula Dam on the South Canadian River between Haskell and McIntosh Counties was about 93 percent complete at yearend. Completion of the project was scheduled for 1965. Keystone Dam, under construction on Arkansas River in Tulsa County, 15 miles west of Tulsa, was 75 percent complete. The project was scheduled for completion in 1965. Dedication ceremonies were held on July 20 at the $35 million multipurpose Oologah Dam on Verdigris River in Rogers County, 27 miles northeast of Tulsa. Construction began in August on Broken Bow Dam on the Mountain Fork River in McCurtain County.

The Bureau of Reclamation, U.S. Department of the Interior, Norman Dam project east of Norman, on the Little River in Cleveland and Oklahoma Counties, was about 56 percent complete. The $18 million multipurpose project would furnish water to Del City, Midwest City, and Norman when completed. Preconstruction activity continued at Arbuckle Reservoir and damsite on Rock Creek in Murray County.

Federal Geological Survey established an office in Newkirk for preliminary survey work on the Kaw Dam and Reservoir. Topographical surveys of eight quadrangles, covering about 476 square miles, will be conducted.

Construction continued at the Grand River Dam Authority Markham Ferry project on the Grand River in Mayes County, 12 miles southeast of Pryor.

METALS

Germanium.—Reclaimed as an accumulation of residue in zinc smelting, germanium was recovered from domestic and foreign ore con-

centrates by The Eagle-Picher Co. at Henryetta, Okmulgee County, and by National Zinc Co. at Bartlesville, Washington County. The residue was shipped to The Eagle-Picher Co. germanium processing plant north of Quapaw, Ottawa County.

Lead.—Twenty-four producers reported lead output from 47 operations compared with 19 producers at 36 operations in 1962. Output of recoverable lead in Ottawa County increased 18 percent; value gained 38 percent. The price of lead at New York on January 1 was 10.00 cents per pound until January 14 when it was raised to 10.5 cents per pound. On June 5, the price was boosted to 10.75 cents per pound; on July 1, to 11.00 cents per pound; and on July 23, to 11.25 cents per pound. Effective August 19, the price increased to 11.5 cents per pound and on September 16, rose to 11.75 cents per pound. On October 8, the price increased to 12.00 cents per pound; on November 20, the price increased to 12.5 cents per pound and remained unchanged for the rest of 1963.

Zinc.—Recoverable zinc production and value in Ottawa County increased 32 percent. Twenty-five producers reported zinc ore output from 49 operations, compared with 20 producers and 40 operations in 1962. The price of zinc at East St. Louis remained at 11.5 cents per pound from January 1 until July 2, then it was boosted to 12.00 cents per pound. On July 30, the price rose to 12.5 cents per pound and, on December 2, it increased to 13.00 cents per pound where it held for the remainder of 1963.

TABLE 21.—Mine production of lead and zinc, in terms of concentrate and recoverable metals [1]

Year	Lead concentrate (galena)		Zinc concentrate (sphalerite)		Recoverable metal content [2]			
					Lead		Zinc	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1954–58 (average)	14,388	$2,475	50,731	$3,766	10,311	$2,980	26,489	$6,325
1959	905	118	2,090	134	601	138	1,049	241
1960	1,687	155	4,715	344	936	219	2,332	602
1961	1,333	130	5,936	405	980	202	3,148	724
1962	3,600	343	18,327	1,278	2,710	499	10,013	2,303
1963	4,317	432	24,329	1,757	3,192	689	13,245	3,046
Total, 1891–1963	1,684,648	163,739	9,786,957	486,050	1,291,570	195,801	5,160,902	778,655

[1] Based on Oklahoma ore (dirt) and old tailing treated at mills during calendar year indicated.
[2] In calculating metal content of the ores from assays, allowance made for smelting losses of both lead and zinc. In comparing values of concentrate (ore) and metal, it should be noted that value given for concentrate is that actually received by producer, whereas value of lead and zinc is calculated from average price for all grades.

Custom Mills and Smelters.—The Eagle-Pitcher Co. at Henryetta, Okmulgee County, operated its horizontal-retort zinc plant throughout 1963. American Metal Climax, Inc., at Blackwell, Kay County, increased production; 10 of the 12 furnace blocks operated most of the year. In August, two additional furnace blocks were prepared for operation. National Zinc Co. at Bartlesville, Washington County, operated its horizontal-retort zinc smelter throughout the year. Domestic and foreign ores and concentrates were treated at the smelters.

TABLE 22.—Tenor of lead-zinc ore milled and concentrates produced

	1962	1963
Total material milled.....short tons..	349,686	479,802
Recovery of concentrate and metal from quantity milled:		
Galena.....short tons..	3,600	4,317
Sphalerite.....do....	18,327	24,329
Galena.....percent..	1.03	.90
Sphalerite.....do....	5.24	5.07
Lead [1].....do....	.77	.67
Zinc [1].....do....	2.86	2.76
Average lead content of galena concentrate.....do....	76.75	75.38
Average zinc content of sphalerite concentrate.....do....	60.70	60.50
Average value per ton:		
Galena concentrate	$95.17	$100.09
Sphalerite concentrate	$69.75	$72.20

[1] Figures represent metal content of crude ore (dirt) as recovered in concentrate. Data on tailing losses not available.

TABLE 23.—Mine production of lead and zinc in 1963, by months, in terms of recoverable metals

(Short tons)

Month	Lead	Zinc	Month	Lead	Zinc
January	371	1,099	August	278	1,039
February	296	1,255	September	193	974
March	265	1,270	October	299	1,252
April	312	1,369	November	239	1,004
May	241	1,130	December	202	895
June	223	845			
July	273	1,113	Total	3,192	13,245

Federated Metals Division of American Smelting & Refinery Co. operated a secondary zinc plant at Sand Springs, Tulsa County.

The Barbara J. mill of American Zinc, Lead & Smelting Co. near Cardin, and the Central mill of the The Eagle-Picher Co. near Commerce, custom-milled ore from the Tri-State District.

Sulfuric acid was recovered as a byproduct from imported zinc ore processed by National Zinc Co. at its plant in Bartlesville.

Tri-State District

Assisted by the Lead-Zinc Mining Stabilization Program (Public Law 87-347), output of lead and zinc in the Tri-State District increased 15 and 20 percent, respectively, in quantity and 35 and 20 percent, respectively, in value. Lead and zinc concentrates gained 17 and 20 percent in quantity, respectively, and 26 and 28 percent, respectively, in value. Oklahoma produced 75 percent of the district's lead concentrate and 79 percent of its zinc concentrate; Kansas accounted for the remainder; no output was reported from southwest Missouri.

Recapitulation of the stabilization program at yearend showed that a total of 36 applications were approved, of which 30 had been certified, 2 had been denied, 3 had been withdrawn, and 1 was in process. By States, Oklahoma had 24 certified, 2 denied, 3 withdrawn, and 1 in process; and Kansas had 6 certified. Since the program was modified during 1963, the producers were required to resubmit their applications; at yearend, reapplications totaled 12, of which 11 were in Oklahoma and 1 in Kansas. Status of payments on sales made to the General Services Administration in 1963 for the Tri-State District by States is shown in table 26. The amount paid to producers under

this program was excluded from value of lead and zinc mine production reported in other tables in this chapter.

TABLE 24.—Mine production of lead and zinc concentrates in Tri-State District, in terms of concentrate and recoverable metals

Year	Lead concentrate (galena)		Zinc concentrate (sphalerite)		Recoverable metal content			
					Lead		Zinc	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1954–58 (average)	20,611	$3,601	88,226	$6,714	14,964	$4,345	46,363	$11,172
1959	1,607	211	4,061	282	1,082	249	2,066	475
1960	3,098	284	8,877	658	1,717	402	4,449	1,148
1961	3,243	352	10,666	716	2,429	500	5,594	1,287
1962	4,890	481	25,564	1,771	3,680	677	13,956	3,210
1963:								
Kansas	1,402	172	6,433	514	1,027	222	3,508	807
Southwest Missouri								
Oklahoma	4,317	432	24,329	1,757	3,192	689	13,245	3,046
Total, 1963	5,719	604	30,762	2,271	4,219	911	16,753	3,853

TABLE 25.—Tenor of lead and zinc ore milled and concentrates produced in the Tri-State District

	1959 [1]	1960 [1]	1961 [1]	1962	1963
Total material milled: Crude ore—short tons	31,750	51,972	180,331	474,219	612,862
Recovery of concentrate and metal from material milled:					
Galena—percent	2.58	1.85	1.67	1.03	0.93
Sphalerite—do	6.71	7.79	5.64	5.39	5.02
Lead [2]—do	2.05	1.18	1.28	.78	.69
Zinc [2]—do	3.54	4.13	2.98	2.94	2.73
Average lead content of galena concentrate—do	81.17	64.86	78.43	76.75	75.21
Average zinc content of sphalerite concentrate—do	58.54	58.88	58.65	60.64	60.52
Average value per ton:					
Galena concentrate	$154.95	$113.62	$111.82	$98.24	$105.68
Sphalerite concentrate	$73.49	$78.40	$67.56	$69.30	$73.82

[1] Lead-zinc concentrates from accumulated slimes excluded.
[2] Metal content of the crude ore (dirt) as recovered in concentrate.

TABLE 26.—Status of payments [1] made on sales in the Tri-State District, by States, in 1963

Status in State or District	Lead		Zinc	
	Short tons	Amount	Short tons	Amount
Kansas:				
Active (4)	626.664	$32,474.52	2,486.288	$70,929.65
Inactive (2)			11.831	260.27
Total (6)	626.664	32,474.52	2,498.119	71,189.92
Oklahoma:				
Active (17)	1,894.855	101,346.36	8,832.412	253,117.79
Inactive (5)	71.276	4,282.34	242.934	8,016.81
Total (22)	1,966.131	105,628.70	9,075.346	261,134.60
Tri-State District:				
Active (21)	2,521.519	133,820.88	11,318.700	324,047.44
Inactive (7)	71.276	4,282.34	254.765	8,277.08
Total (28)	2,592.795	138,103.22	11,573.465	332,324.52

[1] Amount paid to producers is excluded from the value of lead and zinc mine production reported in this chapter.

According to E&MJ Metal & Mineral Markets, the quoted price of 60-percent zinc concentrate began the year at $68 per short ton, on July 22 rose to $72 per ton, on August 5 to $76 per ton, and on December 4 to $80 per ton.

REVIEW BY COUNTIES

Minerals were produced in 76 of the 77 counties. The 10 leading counties, in order of mineral production value, were Garvin, Stephens, Osage, Carter, Kingfisher, Texas, Beaver, Creek, McClain, and Seminole. Crude oil was reported from 67 counties, natural gas from 64, and natural gas liquids from 31. Nonmetals were produced in 60 counties and metals in 1 county. Only those counties with significant production or industry information are discussed in this review (see table 27 for additional details).

Beaver.—Value of mineral production decreased 15 percent as a result of decreased natural gas and crude oil production. Natural gas liquids were recovered at five processing plants. Volcanic ash was mined near Gate by LaRue-Axtell.

Beckham.—Increased output of natural gas accounted for a 71-percent increase in overall mineral value. Natural gas and petroleum were produced mostly from Elk City field. Natural gas liquids were extracted at the Shell Oil Co. Elk City cycling plant.

TABLE 27.—Value of minerals produced in Oklahoma, by counties [1]

County	1962	1963	Minerals produced in 1963 in order of value
Adair		$164,950	Petroleum.
Alfalfa	$4,254,881	3,739,433	Petroleum, natural gas, sand and gravel, stone.
Atoka	(3)	331,197	Stone, petroleum, sand and gravel.
Beaver	43,192,910	36,556,254	Natural gas, petroleum, natural gas liquids, pumice.
Beckham	11,353,377	19,418,470	Natural gas, natural gas liquids, petroleum.
Blaine	3,747,969	3,915,441	Natural gas, gypsum, natural gas liquids, petroleum, stone.
Bryan	2,072,764	2,492,104	Petroleum, natural gas, stone, sand and gravel.
Caddo	12,716,551	11,787,229	Petroleum, natural gas, gypsum, stone, sand and gravel.
Canadian	300,517	850,342	Petroleum, natural gas, gypsum.
Carter	52,601,171	55,954,096	Petroleum, natural gas, natural gas liquids, sand and gravel.
Cherokee	(3)	(3)	Stone.
Choctaw	614,558	280,281	Stone, sand and gravel, petroleum.
Cimarron	12,877,648	11,202,321	Helium, natural gas, petroleum, natural gas liquids.
Cleveland	15,014,973	13,986,213	Petroleum, natural gas, natural gas liquids, sand and gravel.
Coal	2,679,174	2,620,886	Petroleum, natural gas, stone.
Comanche	3,958,954	4,278,921	Stone, natural gas, petroleum, gypsum.
Cotton	4,844,032	5,975,882	Petroleum, sand and gravel, natural gas.
Craig	959,177	1,018,863	Coal, petroleum, natural gas.
Creek	33,631,777	33,698,635	Petroleum, natural gas liquids, natural gas, clays, stone.
Custer	1,321,770	2,105,332	Natural gas, petroleum, clays.
Dewey	1,752,627	5,929,319	Petroleum, natural gas, clays, sand and gravel.
Ellis	536,628	673,543	Petroleum, natural gas.
Garfield	7,873,946	11,772,300	Petroleum, natural gas, natural gas liquids, clays.
Garvin	69,479,785	76,242,267	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Grady	18,470,984	21,793,744	Petroleum, natural gas, natural gas liquids, sand and gravel.
Grant	7,483,072	7,401,069	Petroleum, natural gas, natural gas liquids.
Greer	369,677	341,464	Stone, sand and gravel, petroleum, natural gas, clays.
Harmon	14,025	19,350	Salt.
Harper	26,219,860	19,668,086	Natural gas, natural gas liquids, petroleum, stone.
Haskell	3,492,389	4,080,424	Coal, natural gas.
Hughes	6,484,169	6,365,308	Petroleum, natural gas.
Jackson	1,132,808	763,032	Petroleum, sand and gravel, stone, natural gas.
Jefferson	3,406,767	3,484,594	Petroleum, natural gas.

See footnotes at end of table.

TABLE 27.—Value of minerals produced in Oklahoma, by counties[1]—Continued

County	1962	1963	Minerals produced in 1963 in order of value
Johnston	(3)	(3)	Sand and gravel, stone, petroleum.
Kay	$13,506,513	$13,407,745	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Kingfisher	37,024,589	40,417,380	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kiowa	1,757,366	1,517,327	Stone, petroleum, sand and gravel, natural gas.
Latimer	444,910	222,780	Natural gas.
Le Flore	1,491,152	840,382	Natural gas, coal, stone, sand and gravel.
Lincoln	27,159,833	23,752,436	Petroleum, natural gas, natural gas liquids, stone, clays.
Logan	7,315,866	6,216,914	Petroleum, natural gas, sand and gravel, natural gas liquids.
Love	8,369,753	9,408,031	Petroleum, natural gas liquids, natural gas.
Major	6,529,924	12,391,139	Petroleum, natural gas, natural gas liquids, sand and gravel.
Marshall	6,037,047	5,249,285	Petroleum, natural gas liquids, natural gas.
Mayes	(3)	6,247,054	Cement, stone, clays, petroleum.
McClain	25,707,656	27,663,444	Petroleum, natural gas, natural gas liquids, sand and gravel.
McCurtain	104,401	391,891	Petroleum, stone.
McIntosh	802,682	628,846	Natural gas, stone, sand and gravel, coal, petroleum.
Murray	2,018,731	3,203,347	Stone, petroleum, sand and gravel, natural gas.
Muskogee	3,182,077	4,532,665	Petroleum, sand and gravel, natural gas, stone.
Noble	9,402,027	8,405,401	Petroleum, natural gas, natural gas liquids, stone.
Nowata	5,457,975	5,996,366	Petroleum, stone, natural gas.
Okfuskee	9,001,180	7,633,405	Petroleum, natural gas, natural gas liquids, stone, sand and gravel.
Oklahoma	23,166,947	20,008,732	Petroleum, natural gas liquids, natural gas, sand and gravel, clays.
Okmulgee	5,916,199	5,676,553	Petroleum, natural gas, coal.
Osage	76,621,972	68,710,329	Petroleum, stone, natural gas liquids, natural gas.
Ottawa	3,483,855	4,399,868	Zinc, lead, stone, tripoli.
Pawnee	5,615,960	5,305,721	Petroleum, sand and gravel, natural gas, stone.
Payne	8,008,345	7,352,897	Petroleum, natural gas, stone, natural gas liquids.
Pittsburg	2,375,953	783,146	Coal, natural gas, stone, clays.
Pontotoc	21,722,050	21,925,958	Petroleum, cement, stone, sand and gravel, natural gas liquids, clays, natural gas.
Pottawatomie	12,746,706	11,661,560	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Pushmataha	174,146	(3)	Sand and gravel, stone.
Roger Mills	----------	2,283	Petroleum.
Rogers	8,838,272	8,811,821	Cement, petroleum, coal, stone, clays, natural gas.
Seminole	27,216,141	24,762,256	Petroleum, natural gas liquids, natural gas, stone, sand and gravel, clays.
Sequoyah	2,413,227	1,623,748	Lime, stone, natural gas.
Stephens	63,462,749	74,443,983	Petroleum, natural gas, natural gas liquids.
Texas	38,789,641	37,980,210	Natural gas, petroleum, natural gas liquids, stone, sand and gravel.
Tillman	1,530,702	719,824	Petroleum, sand and gravel, stone.
Tulsa	8,004,184	8,181,180	Petroleum, stone, sand and gravel, clays, natural gas.
Wagoner	539,385	495,996	Petroleum, natural gas.
Washington	14,560,582	14,271,791	Petroleum, cement, stone, clays, natural gas.
Washita	847,174	1,234,318	Natural gas, petroleum, gypsum.
Woods	1,203,351	1,671,494	Natural gas, petroleum, salt, stone.
Woodward	1,618,253	2,109,898	Natural gas, natural gas liquids, petroleum, sand and gravel.
Undistributed	8,261,584	3,347,246	
Total	[2] 855,290,000	872,518,000	

[1] Delaware County is not listed because no production was reported.
[2] Revised figures.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Blaine.—Gypsum was mined northeast of Watonga by Universal Atlas Cement Co. and west of Okeene by Walton Gypsum Co. United States Gypsum Co. quarried and crushed gypsum and operated a large calcining, sheetrock, and plaster products plant at Southard. Limestone was quarried and crushed for the Oklahoma State Highway Department. Pan American Petroleum Corp. placed its new 30-million-cubic-foot-per-day refrigeration absorption plant on stream at Okeene; natural gas from fields in Blaine and Major Counties will be processed at the plant.

Bryan.—Overall mineral production value increased 20 percent. Building sand and construction gravel were prepared from open pits by one producer and the Oklahoma State Highway Department.

Caddo.—Losses in petroleum, natural gas, stone, and sand and gravel output were responsible for the decline in total mineral value; gypsum output increased. Petroleum and natural gas were produced from several fields; Cement, the largest field, furnished more than 3.3 million barrels of oil. Apco Oil Corp. operated its 12,000-barrel-a-day refinery at Cyril throughout the year. Harrison Gypsum Co., Inc., strip mined gypsum near Cement for portland cement and agricultural uses. Dimension and crushed limestone were produced by J. W. McPhearson. Sand for building purposes was produced by one operator.

Carter.—Carter County ranked fourth in total mineral value and production of natural gas liquids and petroleum. Petroleum and natural gas were produced from numerous fields; Fox-Graham, Healdton, Hewitt, and Sho-Vel-Tum fields were the largest. The Sho-Vel-Tum field was the Nation's third largest producing field. Eight plants extracted natural gas liquids. The Sinclair Oil & Gas Co.'s 10-million-cubic-foot-per-day refrigeration absorption plant at Healdton was completed in August. Bell Oil & Gas Co., operated the Ben Franklin Refinery Co. refinery at Ardmore.

Cimarron.—A 13-percent decrease in total mineral value resulted from decreased helium sales, natural gas production, and petroleum production. Shipments of helium decreased 17 percent and value decreased 16 percent although production increased 3 percent. Helium was extracted at the Federal Bureau of Mines Keyes plant from natural gas supplied by Colorado Interstate Gas Co. A new 50-million-cubic-foot-per-day refrigeration absorption plant was placed on stream by Colorado Interstate Gas Co. at Keyes. Several fields in the Keyes area produced natural gas and petroleum.

Cleveland.—Natural gas liquids were recovered at plants operated by Continental Oil Co. and Sunray DX Oil Co. Sand and gravel was produced by four operators for paving use by the Oklahoma State Highway Department.

Comanche.—Dolese Bros. Co. produced crushed limestone at its Richards Spur quarry north of Lawton. Gypsum was mined at an open pit near Fletcher by Texas Gypsum Co. for wallboard manufacturing at its Irving, Tex., plant. Natural gas and petroleum were produced from a group of small fields (comprising three districts) and Fort Sill Reservation field.

Craig.—Total mineral value increased 6 percent as the result of increased coal production. Four operators strip mined coal at seven pits.

Creek.—Petroleum and natural gas were produced from numerous fields; the prolific Cushing and Glenn pool furnished more than 6.1 million barrels of petroleum. Natural gas liquids were recovered at processing plants operated by Kerr-McGee Oil Industries, Inc., Sinclair Oil & Gas Co., and Warren Petroleum Corp. At Sapulpa, clay for manufacturing brick and tile was produced by Sapulpa, Brick & Tile Co. and for pottery, by Frankoma Pottery Co. Limestone was quarried and crushed by Quapaw Co.

Custer.—Total mineral value increased 59 percent as a result of increased output of petroleum and natural gas. Clay for brick and tile was produced by Acme Brick Co.

Garfield.—Successful petroleum exploration in Anadarko Basin has spread northward from Kingfisher County into the southern and southwestern parts of Garfield County as evidenced by about a 140-percent increase in value of petroleum output since 1960. Total mineral value in 1963 increased about 50 percent as a 67-percent gain in petroleum output more than offset production losses in natural gas liquids and clays. Sinclair Oil & Gas Co. recovered natural gas liquids at its Garber field plant at Covington. Champlin Oil & Refining Co. operated a 32,000-barrel-per-day refinery at Enid. Enid Brick & Tile Manufacturing Co. mined clay at pits near the plant.

Garvin.—Garvin County ranked first in total value of mineral production. A 150-percent gain in production value of natural gas was responsible; value of natural gas liquids increased slightly and petroleum value decreased. Natural gas liquids were recovered at plants operated by O. H. Grimes, Lone Star Gas Co., Phillips Petroleum Co., Service Gas Products Co., Sohio Petroleum Co., and Warren Petroleum Corp. Kerr-McGee Oil Industries Inc., operated its 24,000-barrel-per-day refinery at Wynnewood. Building, paving, and fill sand were produced by Lamar Lawson and the Oklahoma State Highway Department.

Grady.—Production gains in petroleum, natural gas, and natural gas liquids were responsible for an 18-percent increase in total mineral value. Natural gas liquids were recovered by Cyprus Mines Corp. processing plant and British-American Oil Producing Co. and Mobil Oil Co. cycling plants. The Dolese Co. obtained sand for building and paving from pits near Tuttle.

Grant.—Decreased output of natural gas accounted for a slight drop in mineral value; value of petroleum and natural gas liquids rose. Natural gas liquids were recovered by Continental Oil Co. at its Medford plant.

Harper.—Total mineral value dropped 25 percent due to decreased production of natural gas and petroleum. Natural gas liquids were recovered at the Sun Oil Co. gasoline plant which processed gas from the huge Laverne gasfield.

Haskell.—Increased production value of both coal and natural gas raised total mineral value 17 percent. Haskell County retained first place in value of coal produced. Only two operators produced coal from two open-pit operations, compared with four operators at five open-pit operations in 1962.

Johnston.—Total mineral value increased 15 percent as a result of the first reported petroleum production and increased sand and gravel output. Pennsylvania Glass Sand Corp. of Oklahoma produced sand for glass and ground silica from pits north of Mill Creek. Dimension limestone for building was produced near Pontotoc by A–D–A Stone Co.; crushed and ground dolomite was produced by Rock Products Manufacturing Corp. Dimension granite was quarried by two operators.

Kay.—Total mineral value declined slightly due to losses in petroleum, natural gas, and stone production that offset gains in natural gas

liquids and sand output. Petroleum and natural gas were produced from numerous fields; natural gas liquids were recovered at plants of Cities Service Oil Co. and Wunderlich Development Co. Cities Service Oil Co. and Continental Oil Co. operated oil refineries at Ponca City. Petrochemical units of the Continental Oil Co. refinery produced benzene, toluene, and propylene hydrocarbons and carbon black. Crushed limestone was produced by Standard Industries, Inc., at its quarry and plant, northeast of Ponca City and at three other locations. Sand for building, paving, and fill purposes was produced by Sober Brothers Concrete, Inc., at Blackwell, and Sober Brothers Sand & Gravel Co. at Ponca City. Blackwell Zinc Co., a division of American Metal Climax, Inc., operated its zinc smelter.

Kingfisher.—A 9-percent gain in total mineral production value raised the county to fifth place; increased production value of natural gas, natural gas liquids, and sand and gravel accounted for the gain. Value of petroleum produced was 3 percent less than in 1962. Natural gas liquids were recovered by Continental Oil Co. Hennessey field plant, Humble Oil & Refining Co. Dover-Hennessey plant, Pan American Petroleum Corp. North Okarche plant, and Sohio Petroleum Co. West Edmond field plant. The Dolese Co. produced sand for building and paving uses from pits near Dover.

Kiowa.—Value of total mineral production was 14 percent below 1962 as declines in stone, petroleum, and natural gas more than offset value of increased sand and gravel production. Dimension granite was quarried near Snyder by two operators and near Hobart by The Century Granite Co., Inc. Roosevelt Materials Co., Inc., produced crushed limestone for concrete aggregate. Southwest Sand Co. produced sand and gravel for building use.

Le Flore.—Total mineral value declined as coal and natural gas production dropped appreciably. Three operators produced coal at underground mines—one less than in 1962. The county ranked fifth in coal production value. Paving gravel was produced for highway surfacing by Oklahoma State Highway Department.

Lincoln.—A 13-percent decrease in total mineral value resulted from production losses in petroleum, natural gas, and natural gas liquids. Numerous fields produced petroleum and natural gas. Natural gas liquids were extracted from natural gas at Apache Gas Products Corp. Kendrick plant, Highway Gasoline Co. Stroud plant, Sunray DX Oil Co. Carney plant, and Texaco Inc. Davenport plant. Allied Materials Corp. operated its 4,000-barrel-per-day refinery at Stroud. Clay for building brick was produced by Stroud Clay Products Co.

Logan.—Petroleum and natural gas were produced from numerous fields; natural gas liquids were recovered by Eason Oil Co. at its Crescent plant. Paving, building, and fill sand were produced by The Dolese Co. and John McConnel.

Love.—An increase of 12 percent in total mineral value resulted from a rise in petroleum and natural gas production; value of natural gas liquids decreased. Natural gas liquids were recovered by the California Oil Co. cycling plant in Southeast Marietta field and Texaco Inc. Enville plant.

Major.—Value of mineral production gained 90 percent as the result of a substantial increase in output of petroleum, natural gas, and na-

tural gas liquids, mostly from Ringwood field. Natural gas liquids were recovered by National Fuels Corp. at its Ringwood plant. Construction sand was produced by Orin Law.

Marshall.—Petroleum and natural gas were produced from several fields; most important was Cumberland field which yielded over 1.1 million barrels of oil. Natural gas liquids were recovered by National Fuels Corp. Madill field plant and Service Gas Product Co. Aylesworth field plant.

Mayes.—Limestone and clay were produced for cement manufacture by Oklahoma Cement Co. at its plant southeast of Pryor. Limestone was quarried and crushed for roadstone, concrete aggregate, and agstone by Standard Industries, Inc. A small amount of petroleum was produced. Construction of the Markham Ferry project on Grand River, 12 miles southeast of Pryor, continued throughout the year. Progress on the dam at yearend was ahead of schedule.

McClain.—Value of minerals produced in 1963 increased 8 percent over that of 1962. Petroleum and natural gas were produced at numerous small fields. Natural gasoline was recovered at Sohio Petroleum Co. Norman plant, Sunray DX Oil Co. Criner plant, and Universoil, Inc., plant in Dibble field. The Dolese Co. and Oklahoma State Highway Department produced sand for construction and paving uses.

McIntosh.—Sandstone was quarried and crushed for use as concrete aggregate and roadstone. U.S. Army Corps of Engineers used a considerable amount on Eufaula Dam construction. Value of coal output increased slightly. Natural gas and petroleum were produced, mostly from Coalton and Stidham fields. Sand was produced for fill by Fyfe Sand & Gravel Co., gravel was produced for paving by the McIntosh County highway department.

Murray.—Limestone was quarried and crushed at Rayford and Big Canyon quarries of Dolese Bros. Co.; elsewhere, by two other producers. Building and paving sand and gravel were produced by Joe Brown Sand & Gravel Co., three other producers, and Oklahoma State Highway Department. Two fields produced petroleum and natural gas.

Muskogee.—Petroleum and a small quantity of natural gas were produced. Sand for structural uses, paving, and fill was dredged from Arkansas River by Yahola Sand Co. and by Oklahoma State Highway Department. At Muskogee, Fansteel Metallurgical Corp. operated its columbium-tantalum plant. Callery Chemical Co. closed its high-energy fuel plant at Muskogee.

Noble.—Petroleum and natural gas were produced from numerous fields; natural gas liquids were recovered at the Lucien unit plant of Gasoline Plant Management Co. and at Wunderlich Development Co. Billings plant. Limestone was quarried and crushed for concrete aggregate and roadstone by Okan Materials, Inc.

Nowata.—Petroleum and natural gas were produced from six fields. Crushed limestone was produced by Peerless Rock Co. for concrete aggregate, roadstone, and aglime.

Okfuskee.—Petroleum and natural gas were produced from numerous fields. Production from Olympic field declined to 529,000 barrels of oil. Natural gas liquids were recovered at the Weleetka plant of

Grimes & Grimes and at the Laffoon plant of Kerr-McGee Oil Industries, Inc., until April when it was shut down.

Oklahoma.—Total mineral value decreased 14 percent as output of petroleum and natural gas liquids declined. Petroleum and natural gas were produced from numerous fields; Oklahoma City field yielded 2.3 million barrels of oil. Natural gas liquids were recovered at Champlin Oil & Refining Co. Witcher field plant; Cities Service Oil Co. plant in Oklahoma City field; Patton & Swab, Inc., Edmond field plant; and Phillips Petroleum Co. Edmond field and Oklahoma City field plants. Building and paving sand was produced by four operators and gravel was produced for Oklahoma State Highway Department. Clay for manufacturing brick and tile was obtained from pits in the western part of Oklahoma City by Acme Brick Co. Clay for lightweight aggregate was mined and expanded by Chandler Materials Co. at its Haydite lightweight aggregate plant near Choctaw.

Okmulgee.—Petroleum and natural gas were produced from numerous fields. Phillips Petroleum Co. operated its 19,000-barrel-per-day refinery at Okmulgee. Coal was strip mined near Henryetta by Carbon Hill Coal Co.

Osage.—Osage County, the State's leading oil producer, dropped to third in total mineral value as petroleum, natural gas liquids, natural gas, and stone declined over 10 percent. Burbank field produced 13.7 million barrels of oil under an extensive waterflooding program and remained one of the most prolific. Natural gas liquids were recovered by Phillips Petroleum Co. Reserve plant. Limestone was quarried and crushed by Standard Industries, Inc., and Sedan Limestone Co. for concrete aggregate and roadstone.

Ottawa.—Oklahoma's lead and zinc and a major part of the Tri-State District output was supplied from mines in Ottawa County. The Lead-Zinc Stabilization Program did much to increase production. At Quapaw, the Rare Metals plant of The Eagle-Picher Co. operated during the year. Chat, a product of zinc and lead milling, was supplied by six producers at eight locations. Tripoli was quarried in east-central Ottawa County by American Tripoli Division of The Carborundum Co. and processed in its plant at Seneca, Mo.

Pawnee.—Petroleum and natural gas were produced from numerous fields. Limestone was quarried and crushed by Standard Industries, Inc., and W. O. Cox. Construction and paving sand was produced by Tulsa Sand Co., Inc.

Payne.—Petroleum and natural gas were produced from numerous fields; Yale-Quay, with a production of nearly 700,000 barrels of oil, was largest in the county. Hydrocarbons Development Corp. recovered natural gas liquids at its Norfolk field plant. Midland Cooperatives, Inc., operated its Cushing refinery; early in the year, crude capacity was increased from 13,000 to 15,500 barrels per stream day and visbreaking and fluid cat-cracking capacities were increased. Kerr-McGee Oil Industries, Inc., Cushing refinery produced only high-quality lubricating oils. Crushed limestone was produced by Standard Industries, Inc., near Ripley and by Rowland Rock Co. for concrete aggregate and roadstone.

Pittsburg.—Pittsburg County dropped to fourth place in production value of coal with closing of the Lone Star Steel Co. underground

mine near Hartshorne. Limestone was quarried for U.S. Army Corps of Engineers, Tulsa District, for use as riprap and roadstone on Eufaula Dam construction project. Clay for manufacturing brick and tile was produced by Oklahoma State Penitentiary west of McAlester. Natural gas was produced from three fields near Quinton.

Pontotoc.—Increased production of petroleum, natural gas liquids, sand and gravel, and clays offset a decrease in cement, stone, and natural gas output for a small net gain in total mineral value. The Ada plant of Ideal Cement Co. operated throughout the year. Clay, shale, and limestone were quarried near Lawrence by Ideal Cement Co. for use in its plant. Dimension limestone was quarried near Fittstown by Townsend Brothers Quarry. Limestone was quarried and crushed for concrete aggregate and roadstone by Townsend Brothers Quarry and others. Mid-Continent Glass Sand Co. produced glass and molding sands at its quarry near Roff. Petroleum and natural gas were produced from many fields; natural gas liquids were recovered by Fitts field gasoline plant at Humble Oil & Refining Co.

Pottawatomie.—Petroleum and natural gas were produced from numerous fields; St. Louis, the largest, produced over 1.5 million barrels of petroleum. Natural gas liquids were extracted from natural gas at St. Louis plant of Sinclair Oil & Gas Co.

Rogers.—Petroleum and natural gas were produced from three fields; Chelsea district produced most of the crude oil. Output of coal, strip mined by Sinclair Coal Co., ranked the county second among the State's coal producers. Dewey Portland Cement Division, Martin-Marietta Corp., quarried limestone and shale for manufacturing cement at its plant northeast of Tulsa. Capacity of the plant was being doubled to absorb the increased work caused by the closing of the firm's Washington County plant. Shale was mined by Chandler Materials Co. as raw material for its lightweight aggregate plant. U.S. Army Corps of Engineers, Tulsa District, completed work on Oologah Dam on Verdigris River. On July 20, the dam was dedicated as a part of the overall Arkansas River Basin Development Program for navigation and flood control.

Seminole.—Petroleum and natural gas were produced from numerous fields; Seminole City field was most prolific, producing 785,000 barrels. Natural gas liquids were recovered by Phillips Petroleum Co. Wewoka field plant, Redco Corp. Seminole plant, and Sinclair Oil & Gas Co. Greater Seminole field plant. Limestone was quarried and crushed by Quality Material Co. for concrete aggregate and roadstone. Clay for manufacturing brick and tile was obtained west of Wewoka by Wewoka Brick & Tile Co.

Sequoyah.—Limestone was mined and crushed north of Marble City at the St. Clair Co. lime quarry. Part of the limestone was burned at Sallisaw in the company kilns; the remainder was used for soil conditioning and highway construction and maintenance. Natural gas was produced from a small field.

Stephens.—Total value was 17 percent greater than in 1962 and, because of increased petroleum and natural gas output, the county ranked second in total mineral value, second in petroleum production,

747-416—64——57

and sixth in natural gas output. Natural gas liquids were recovered by Mobil Oil Co. Duncan plant; Service Gas Products Co. plant near Marlow; Skelly Oil Co. Velma plant; and Warren Petroleum Corp. plant near Marlow. Sunray DX Oil Co. operated an oil refinery at Duncan.

Texas.—Texas County ranked first in value of natural gas produced from the vast Hugoton gasfield and sixth in total mineral value. Natural gas liquids were recovered near Guymon by Cities Service Oil Co. and Hugoton Plains Gas & Oil Co.; near Hooker, by Dorchester Gas Producing Co.; near Tyrone, by Excelsior Oil Corp; in the Postle-Hough field by Mobil Oil Co.; and at Richland by Anadarko Production Co. Building sand was produced by Stewart Brothers Sand & Gravel Co.

Tulsa.—The Texas Co. and Sunray DX Oil Co. refineries, in west Tulsa, operated throughout the year. Sunray DX Oil Co. began constructing a new $3.4 million solvent extraction plant as the final phase of a 6-year, $30 million modernization program. Near Garnett, crushed limestone was produced by Anchor Stone Co., Chandler Materials Co., Murray Limestone Products, Standard Industries, Inc. (three quarries), Tulsa Rock Co., and three other operators. Construction and paving sand was produced by 10 operators from locations along Arkansas River. In Tulsa, brick and tile were manufactured by Acme Brick Co. U.S. Army Corps of Engineers, Tulsa District, continued work on Keystone Dam on Arkansas River.

Washington.—Total value of mineral production was 2 percent less than in 1962. Gains in cement, stone, and clay production failed to offset losses in petroleum and natural gas production. Petroleum and natural gas were produced from five districts. Dewey Portland Cement Co., division of Martin-Marietta Corp., quarried limestone and clay east of Dewey for manufacturing portland cement; the Dewey plant closed on November 1 and all work was transferred to the company's plant near Tulsa. Limestone was quarried and crushed by M. E. Stewart & Sons Rock Products Co., east of Bartlesville. Sulfuric acid, a byproduct from imported zinc ores, was produced at the Bartlesville smelter at National Zinc Co.

Washita.—Natural gas and petroleum were produced from several small fields and from part of the prolific Elk City field. Agricultural Gypsum Corp. stripped gypsum from a surface deposit south of Colony for soil conditioner.

Woods.—Several small fields produced natural gas and petroleum. Ezra S. Blackmon recovered salt by solar evaporation from ponds adjacent to Cimarron River west of Freedom.

Woodward.—Natural gas and petroleum were produced. Natural gas liquids were extracted from natural gas at the new Mooreland plant of Pan American Petroleum Corp. Sand for building and fill uses was produced by Klines Sand Pit.

The Mineral Industry of Oregon

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Oregon Department of Geology and Mineral Industries for collecting information on all minerals except fuels.

By Frank B. Fulkerson,[1] William N. Hale,[2] and Gary A. Kingston[3]

OREGON'S mineral production value rose over $10 million because of greater output of sand and gravel, stone, and cement for construction purposes. The 1963 value was a record $62.7 million, compared with $52.5 million in 1962. Other nonmetal commodities were clays, diatomite, lime, and pumice. Nickel ore was the principal product of metal mining in Oregon. Silver output reached the highest level since 1942; and gold, the highest since 1957. Small values in copper, lead, mercury, uranium and zinc also were produced.

TABLE 1.—Mineral production in Oregon [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays---thousand short tons	249	$305	279	$330
Diatomite---do	50	2	150	3
Gold (recoverable content of ores, etc.)---troy ounces	822	29	1,809	63
Lime---thousand short tons	78	1,514	87	1,835
Nickel (content of ore and concentrate)---short tons	13,110	(2)	13,394	(2)
Perlite---do	3	(3)		
Pumice and volcanic cinder---thousand short tons	(2)	(2)	422	664
Sand and gravel---do	14,869	14,556	15,715	18,850
Silver (recoverable content of ores, etc.)---troy ounces	6,047	7	58,234	74
Stone---thousand short tons	18,258	20,977	19,692	24,197
Uranium ore---short tons	2,722	112	1,763	45
Zinc (recoverable content of ores, etc.)---do			3	1
Value of items that cannot be disclosed: Asbestos (1962), cement, copper, gem stones, iron ore (includes pigment material), lead, mercury, and values indicated by footnote 2		14,956		16,630
Total		52,458		62,692

Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Less than $500.

The only large nonmetal-mineral-industry construction project was a lime plant being built by Ash Grove Lime & Portland Cement Co. at Portland. The plant would use limestone brought by barge from Texada Island, British Columbia. In metal processing, Hanna Nickel

[1] Economist, Bureau of Mines, Albany, Oreg.
[2] Geologist, Bureau of Mines, Albany, Oreg.
[3] Mineral specialist, Bureau of Mines, Albany, Oreg.

Smelting Co. contracted with Bonneville Power Administration for delivery of additional power in 1964. The energy would permit a 20- to 25-percent increase in ferronickel production at Riddle.

Major oil companies continued exploration surveys off the Oregon coast.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$30,148	1958	$46,987
1953	25,765	1959	50,044
1954	35,054	1960	55,483
1955	34,059	1961	53,238
1956	34,865	1962	52,593
1957	44,078	1963	62,352

Consumption, Trade, and Markets.—Much of Oregon's mineral-industry output was sold or used locally. Continued improvement in business conditions in the State benefited the mineral industries. Total personal income gained 5.6 percent, and per capita personal income was up 4.5 percent. Average monthly employment increased, owing to advances in wholesale and retail trade, service industries, and the Government sector. Construction and manufacturing employment also gained. Average monthly unemployment dropped to 4.7 percent of the total labor force, compared with 5.2 percent in 1962. The gain in construction was due largely to increased highway and other heavy building. A $70.4 million contract for construction of the John Day Dam and Lock on the Columbia River between Oregon and Washington was awarded in September. Expenditures for highway contract work totaled $74.3 million, compared with $58.3 million in 1962.

Employment.—The Oregon Employment Department reported that employment in mining, primary metals, stone, clays, and glass products averaged 9,800, compared with 9,500 in 1962.

Government Programs.—An Office of Minerals Exploration contract was in effect at Pacific Minerals & Chemical Co., Inc., mercury prospects in Crook County.

The Bureau of Mines, Albany Office of Mineral Resources, prepared economic reports on ferroalloys, copper, lead, zinc, magnesium, sulfur, and phosphate rock for the Bonneville Power Administration as part of that agency's economic base study to project power markets in the Pacific Northwest.

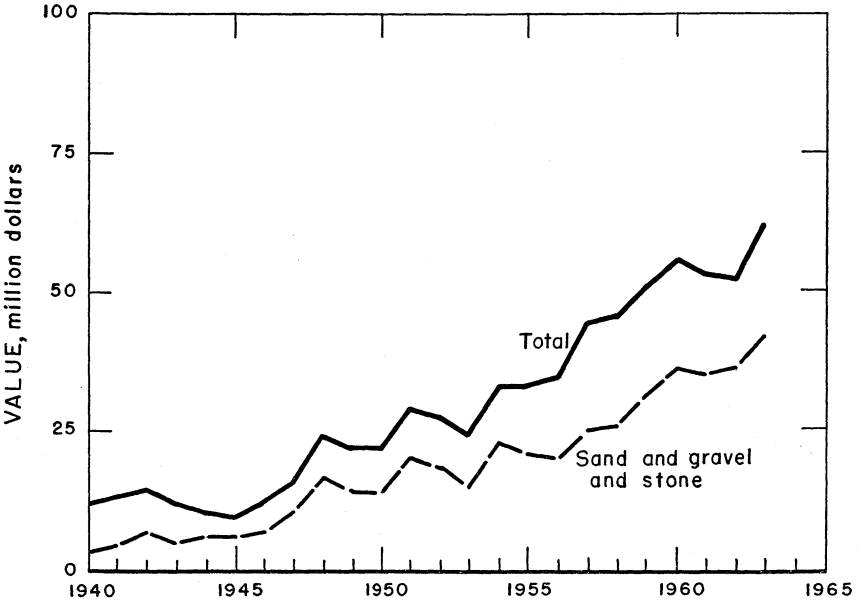


FIGURE 1.—Value of sand and gravel and stone, and total value of mineral production in Oregon, 1940–63.

TABLE 3.—Indicators of Oregon business activity

	1962	[1] 1963	Change, percent
Personal income:			
Total ..... millions	$4,349.0	$4,592.0	+5.6
Per capita	2,407.0	2,515.0	+4.5
Construction activity:			
Building permits ..... millions	227.7	214.5	−5.8
Heavy engineering awards ..... do	131.3	274.7	+109.2
Value of highway contracts awarded ..... do	76.6	107.6	+40.5
Expenditures on highway contract work ..... do	58.3	74.3	+27.4
Cement shipments to and within Oregon thousand 376-pound barrels	3,045.2	3,189.4	+4.7
Cash receipts from farm marketing ..... millions	$435.8	$425.7	−2.3
Factory payrolls ..... do	$807.0	$851.0	+5.4
Annual average labor force and employment:			
Total labor force ..... thousands	733.8	744.5	+1.5
Unemployment ..... do	38.2	35.3	−7.6
Employment:			
Construction ..... do	26.1	27.7	+6.1
Lumber and wood products ..... do	68.9	68.4	−.7
Food products ..... do	20.9	21.7	+3.8
All manufacturing ..... do	143.4	145.2	+1.3
All industries ..... do	695.0	707.2	+1.8

[1] Preliminary figures.

Sources: Survey of Current Business, Construction Review, Pacific Builder & Engineer, State Highway Commission, State Employment Department, and Bureau of Mines.

TABLE 4.—Employment and payrolls in mineral-industry establishments subject to Oregon unemployment-compensation law, by industries

Industry	1962		1963	
	Employment	Payrolls (thousands)	Employment	Payrolls (thousands)
Mining	1,263	$7,272	1,335	$8,667
Stone, clay, and glass products:				
Glass and pottery	370	2,254	421	2,746
Hydraulic cement	401	2,760	420	2,959
Structural clay products	146	731	145	743
Concrete, gypsum, and plaster products	1,785	11,169	1,970	13,132
Cut-stone and stone products	38	225	41	230
Miscellaneous	80	450	83	458
Total	2,820	17,589	3,080	20,268
Primary metals:				
Blast furnaces, steelworks, rolling and finishing mills	1,260	9,343	1,404	10,562
Primary smelting and refining of nonferrous metals	1,757	12,036	1,496	10,196
Iron and steel foundries	1,878	12,075	1,923	13,033
Nonferrous foundries	338	1,961	358	2,114
Secondary smelting and refining of nonferrous metals and miscellaneous industries	172	1,106	167	1,074
Total	5,405	36,521	5,348	36,979
Industrial chemicals	427	2,963	422	3,124
Petroleum refining and related products	352	2,190	407	2,316
Grand total	10,267	66,535	10,592	71,354

Source: Oregon Employment Department. Industries may vary from those in the Bureau of Mines canvass.

TABLE 5.—Employment and injuries in the mineral industries

Year and industry	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1962:						
Quarries and mills [1 2]	874	205	1,431,212	2	50	36
Nonmetal mines and mills	174	161	223,791		10	45
Sand and gravel operations [2]	851	186	1,263,058		29	23
Metal mines and mills	174	137	190,430		4	21
Coal mines	6	57	2,736			
Total	2,079	187	3,111,227	2	93	31
1963: [3]						
Quarries and mills [1 2]	928	209	1,549,226		53	34
Nonmetal mines and mills	202	174	281,761		5	18
Sand and gravel operations [2]	852	205	1,396,337		29	21
Metal mines and mills	143	182	208,309		7	34
Coal mines	4	11	346			
Total	2,129	202	3,435,979		94	27

[1] Includes cement- and lime-processing plants.
[2] Includes only commercial operations.
[3] Preliminary figures.

Water.—According to a Bureau of Mines survey of water requirements (exclusive of smelters, refineries, and cement plants) of the mineral industry in 1962, approximately 2.9 billion gallons of water was required by the industry for processing purposes.

Of this amount, approximately 2.7 billion gallons was required for processing sand and gravel; the remainder was required by metal and nonmetal mines, quarries, and mills. Most of the water used for processing mineral commodities was returned to the source; on the

average, from 1 to 5 percent of the water requirement was consumed in the product or evaporated. About 1 percent of the water required for processing purposes was recirculated.

TABLE 6.—Water use in the mineral industry in 1962

(Million gallons)[1]

Water requirements for—	New water	Recirculated water	Total water use	Water discharged	Water consumed
Metal mines and mills	27		27	27	1
Nonmetal mines and mills	211		211	195	16
Sand and gravel mines and processing plants	2,671	36	2,707	2,522	150
Petroleum (drilling)	2		2		
Total	2,911	36	2,947	2,743	166

[1] Owing to rounding, individual items may not add to totals shown.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—There was no production of asbestos in 1963. Testing of cross-fiber crysotile asbestos removal from serpentine, at an experimental operation north of Mt. Vernon in Grant County, was the subject of a report.[4]

Cement.—Production and shipments of cement were 23 percent greater than in 1962. Increased production and shipments resulted from greater requirements for cement by the construction industry; building activity in the State was hampered the previous year because of a strike. Output was from three plants—one each in Baker, Clackamas, and Jackson Counties. Shipments were made chiefly within the State; out-of-State shipments were mainly to Idaho and Washington, with smaller quantities to northern California and Alaska.

Trucks continued to be the principal method of transport; however, water and rail movement increased. The ratio of bulk to container (paper bag) shipments from producing plants was about 8:1.

Combined production from nine cement plants in Oregon and Washington was 7,798,816 barrels (376 pounds each) of finished portland cement; the same plants shipped 7,727,348 barrels of portland cement. The average value of portland cement shipped by Oregon and Washington producers was $3.57 per barrel, f.o.b. plant, compared with $3.53 in 1962.

Clays.—Clays sold or used by producers in Oregon advanced 12 percent over the 1962 total, mainly because of increased production of clays for cement.

Miscellaneous clay production used in making heavy clay products, principally building brick and draintile, was 11 percent higher than in 1962. Miscellaneous clay was produced in Benton, Clackamas, Jackson, Klamath, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties. Shale used at cement plants was produced in Baker and Jackson Counties.

[4] Wagner, N. S. Coast Asbestos Co. Operations, Grant County, Oregon. Ore Bin, v. 25, No. 12, December 1963, pp. 171-176.

Shale was expanded at two plants in Washington County by Cloverleaf Mines, Ltd. (formerly Smithwick Concrete Products Co.), and Empire Lite-Rock, Inc. (formerly Northwest Aggregate, Inc.). The bloated material was marketed mainly for use as lightweight aggregate in concrete.

Bentonite was processed at an operation in Bend by Anderson Mining & Development Co. Bentonitic clay from the Silver Wells operation, about 64 miles southeast of Prineville, was trucked to the mill and beneficiated by pulverizing and drying. Sized fractions were marketed for use as a forest fire retardant, a binder in making stockfeed pellets, a sealer in irrigation canals, and a filler in insecticides.

Bentonitic clay was processed by Pacific Mining Co. at a plant near Molalla. The absorbent clay was processed with drying and size-separation equipment for use as cat litter, as a flour-sweeping compound, and as an inert carrier in insecticides.

Diatomite.—Crude diatomaceous earth from an operation near Silver Lake in Lake County was trucked to Eugene to be processed and sold for pet litter by Pacific Diatomite Corp.

Lime.—Production by three companies totaled 87,000 tons of lime valued at $1,835,228.

Chemical Lime Co., Baker, produced and sold 40,825 tons of quicklime for industrial use in making calcium carbide and cyanamide, in pulp manufacture, and at aluminum and steel plants. Hydrated lime production, totaling 3,600 tons, was sold for use in paper manufacturing, sugar refining, and water purification. Pacific Carbide & Alloys Co., Portland, produced 15,130 tons of quicklime for use in making calcium carbide. Amalgamated Sugar Co., Nyssa, made 27,126 tons of quicklime for use in sugar refining.

Four pulp mills reclaimed lime from calcium carbonate sludge for use in paper manufacturing.

Ash Grove Lime & Portland Cement Co. began constructing a 250-ton-per-day lime plant on a 30-acre tract in Portland's Rivergate industrial district. The plant, which would be supplied with limestone from Texada Island, British Columbia, was being installed to facilitate service to northwestern customers presently being supplied from the company's Springfield, Mo., operation.

Perlite.—Supreme Perlite Co., Portland, expanded crude perlite from Nevada. The expanded product was used mainly as a building-plaster aggregate; small quantities were marketed for soil conditioning and for concrete aggregate.

Pumice and Volcanic Cinders.—Output of pumice and pumiceous materials (volcanic cinder and scoria) sold or used by producers totaled 422,369 tons valued at $664,082.

Numerous volcanic cinder deposits yielded material for county, State, and Federal road construction.

Central Oregon Pumice Co. and Boise Cascade Pumice produced pumice and volcanic cinder at quarries near Bend. Processed material was sold to leading concrete-products plants throughout the Northwest, California, and Canada. Small quantities were used for insulation purposes.

Sand and Gravel.—Output of sand and gravel totaled 15.7 million tons, compared with 14.9 million tons in 1962. The rise was largely

due to increased requirements for sand and gravel by the State highway department.

TABLE 7.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	2,839	$3,402	3,365	$4,415
Railroad ballast	(1)	(1)	51	54
Road material	4,997	5,833	4,500	5,413
Other [2]	1,793	1,143	1,014	1,143
Total	9,629	10,379	8,929	11,026
Government-and-contractor operations:				
Building	153	166	6	6
Road material	4,992	3,954	6,699	7,774
Other [2]	95	58	81	44
Total	5,240	4,178	6,786	7,824
All operations:				
Building	2,992	3,569	3,371	4,421
Railroad ballast	(1)	(1)	51	54
Road material	9,989	9,786	11,199	13,188
Other [2]	1,888	1,201	1,095	1,188
Grand total [3]	14,869	14,556	15,715	18,850

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Includes fill material, special sands, and sand and gravel used for miscellaneous purposes.
[3] Owing to rounding, the individual items may not add to totals shown.

Sand and gravel output by commercial firms was 8.9 million tons, and Government-and-contractor production was 6.8 million tons, compared with 9.6 and 5.2 million tons, respectively, in 1962.

Production was reported from 34 of the 36 counties. Output exceeding 2.5 million tons was reported in Lane and Multnomah Counties; over 1 million tons each was mined in Douglas, Jackson, and Sherman Counties.

Stone.—Output of stone reached a record 19.7 million tons valued at $24.2 million, compared with 18.3 million tons valued at $21 million in 1962.

The rise resulted from increased quantities of stone used at U.S. Army Corps of Engineers dam-building projects and at State and Federal road projects. Stone output by commercial concerns was 5.5 million tons, and Government-and-contractor production was 14.2 million tons, compared with 3.4 and 14.9 million tons, respectively, in 1962.

Basalt continued to be the principal stone quarried. Output of basalt, 14 percent higher than that of 1962, was used for roadstone, ballast, and riprap.

The quantity of limestone quarried was 824,155 tons, compared with 900,740 tons in 1962. The decline largely was due to more imports of limestone from Canada for use in making calcium carbide and cement. Limestone for industrial use was quarried in Baker, Josephine, and Polk Counties. The largest tonnage produced was consumed by the cement industry, followed by the sugar, lime, paper, metallurgical, and agricultural industries.

TABLE 8.—Stone sold or used by producers, by uses
(Thousand short tons and thousand dollars)

Use	1962		1963	
	Quantity	Value	Quantity	Value
Building (dimension stone)	2	$20	3	$19
Concrete and roadstone	9,403	12,246	13,656	17,161
Railroad ballast	(1)	(1)	446	585
Riprap	7,737	6,998	4,661	4,981
Other [2]	1,116	1,714	927	1,451
Total [3]	18,258	20,977	19,692	24,197

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Used at cement, paper, metallurgical and chemical plants; at sugar refineries; and for miscellaneous unspecified purposes.
[3] Owing to rounding, individual items may not add to total shown.

Bristol Silica Co. continued to produce industrial silica (quartz) near Gold Hill, Jackson County. Processed silica was marketed for manufacturing abrasives, ferrosilicon, silica refractories, and other industrial purposes. White quartz was marketed for decorative stone and roofing granules.

Stone was produced from operations in 35 of the 36 counties; output exceeded 4 million tons in Lane County and 1 million tons each in Douglas and Sherman Counties.

Talc and Soapstone.—Soapstone mined in northwestern Washington was ground at the Portland plants of Stauffer Chemical Co. and Miller Products Co. Output of ground soapstone, which was used as an inert carrier in insecticides, declined sharply from that of 1962.

Vermiculite (Exfoliated).—Production and shipments of exfoliated vermiculite were moderately higher than in 1962. Vermiculite Northwest, Inc., Portland, utilized crude vermiculite shipped from Montana, and Supreme Perlite Co., Portland, exfoliated crude material imported from South Africa. The expanded material was used mainly for loose-fill insulation. Other uses were for special fireproofing applications, as a plaster and concrete aggregate, as a chemical carrier, and as a fertilizer conditioner.

METALS

Alloy Metals.—Union Carbide Corp., Portland; Hanna Nickel Smelting Co., Riddle; and National Metallurgical Co., Springfield, were the only alloy-metal operations in the State. The Union Carbide plant, producing ferromanganese and ferrosilicon alloys and calcium carbide, consumed 14.8 percent more electric energy than in 1962 (see Multnomah County); Hanna Nickel Smelting Co. announced an expansion program to increase ferronickel production (see Douglas County); and National Metallurgical, producer of silicon metal and a subsidiary company of American Metal Climax, Inc., reported that the Springfield plant production capacity would be increased (see Lane County).

Aluminum.—Total primary ingot production from two plants—Harvey Aluminum, Inc., The Dalles, and Reynolds Metals Co., Troutdale—was the lowest since 1958. The Reynolds plant accounted for the production drop, which resulted from market-related cutbacks made by the company during the latter half of 1962. Reynolds

Metals announced that the Troutdale plant, one of the company's less modern operations, was to undergo a $500,000 capital improvement program.

More than 500 acres of bauxite-bearing farmland south of Salem, Marion County, was purchased by Reynolds Metals Co. to be retained as an emergency raw material source. The ferruginous bauxite present in the area is of low grade in comparison with ore being utilized. Reynolds' purchase was within a 3,000-acre tract previously optioned and explored by Harvey Aluminum, Inc.

Copper.—Three mines—Standard and Buffalo, Grant County, and Oregon King, Jefferson County—accounted for a small quantity of recoverable copper produced during the year. Approximately one-third of the total production was from ore shipped by Standard Mines, Inc., to the Tacoma smelter; the remainder came from gold-silver and silver ores mined from the Buffalo and Oregon King mines.

Gold.—A sizable increase in gold production—1,809 ounces compared with 822 the previous year—made output the highest since 1957.

Placer gold from 14 operations totaled 528 ounces and was recovered from more than 63,000 cubic yards of alluvial material. The three largest operations were the Joe Joe and Davis placers (Josephine County) and the Mormon Basin placer (Malheur County).

Sixteen lode mines were worked to yield 1,281 ounces of gold, nearly all of which came from the Oregon King (Jefferson County) and Buffalo (Grant County) mines.

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
1954–58 (average)	19	23	2,657	3,154	$110	11,069	$10
1959	10	27	356	686	24	242	(3)
1960	13	34	1,231	835	29	284	(3)
1961	15	27	782	1,054	37	2,022	2
1962	14	21	2,117	822	29	6,047	7
1963	16	14	4,599	1,809	63	58,234	74
1852–1963			(4)	5,795,326	130,799	5,439,734	5,011

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	10	$6	4	$1			$128
1959							24
1960	6	4					33
1961	(5)	(5)	(5)	(5)	3	$1	44
1962	(5)	(5)	(5)	(5)			43
1963	(5)	(5)	(5)	(5)	3	1	154
1852–1963	(5)	(5)	(5)	(5)	179	25	140,671

[1] Includes recoverable metal content of gravel washed (placer operations), old tailings retreated, ore milled, and ore shipped to smelters during calendar year indicated. Owing to rounding, individual items may not add to totals shown.
[2] Does not include gravel washed.
[3] Less than $500.
[4] Data not available.
[5] Figure withheld to avoid disclosing individual company confidential data.

Iron Ore.—Approximately 3,000 acres in Clatsop County was being explored for potentially economic quantities of magnetite (iron oxide mineral) sand. The Bunker Hill Co., a lead-zinc mining and smelting company with headquarters at Kellogg, Idaho, obtained leases on public land to determine by drilling the probable iron content of beach sands in the Clatsop Spit area down to a depth of 60 to 80 feet. Much of the land under consideration had been investigated previously by State and Federal mining agencies, which in general had arrived at the conclusion that concentration of the iron mineral was insufficient to justify commercial exploitation. The Bunker Hill Co., interested in the area by Pacific Power and Light Co., hoped that additional exploratory drilling might show a more favorable source

The mining company speculated, pending determination of the resource adequacy, that a $12 million ore-reduction plant might be constructed to produce a sponge-iron product for possible sale to west coast and foreign consumers.

TABLE 10.—Gold production at placer mines

Year	Mechanical and hydraulic methods [1]			Small-scale hand methods			Total [2]		
	Number of operations	Material treated (thousand cubic yards)	Gold (troy ounces)	Number of operations	Material treated (thousand cubic yards)	Gold (troy ounces)	Number of operations	Material treated (thousand cubic yards)	Gold (troy ounces)
1954–58 (average)	15	372	1,193	8	7	62	23	379	1,255
1959	19	54	396	8	4	54	27	58	450
1960	14	226	610	20	5	58	34	231	668
1961	10	104	570	17	17	135	27	121	705
1962	7	94	342	14	15	69	21	108	411
1963	[3] 4	[4] 27	292	10	36	236	14	63	528

[1] Combined to avoid disclosing individual company confidential data.
[2] Data may not add to totals shown because of rounding.
[3] Includes 3 hydraulic operations and 1 nonfloating washing plant.
[4] Does not include gravel washed at commercial gravel plants to produce byproduct gold.

TABLE 11.—Mine production of gold, silver, copper, lead, and zinc in 1963, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold	11	273	53	20	----------	[2]	200
Dry silver, gold-silver, and gold old tailings [3]	5	4,278	1,193	58,113	[2]	[2]	5,800
Copper	1	48	35	39	[2]	----------	----------
Total lode	16	4,599	1,281	58,172	[2]	[2]	6,000
Placer	14	[4]	528	62	----------	----------	----------
Grand total	30	4,599	1,809	58,234	[2]	[2]	6,000

[1] Because some mines produce more than 1 class of material, data will not necessarily add to total shown.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Combined to avoid disclosing individual company confidential data.
[4] 63,259 cubic yards of placer gravel washed (does not include gravel washed at commercial gravel plants to produce byproduct gold).

The magnetite concentrations contained in the beach sands were to be mined by bucket-line dredge from which the iron ore would be transported aboard barges that could be floated up to the dredging area via a canal from the Columbia River.

The proposed direct-reduction process represented new technology that could help make the operation profitable. Also, the use of a dredge to mine the ore would be comparatively inexpensive method, which was an additional favorable aspect of the proposed venture.

Lead.—A small tonnage of lead was recovered as a byproduct of gold and silver ores mined principally from the Oregon King mine (Jefferson County) and the Buffalo mine (Grant County).

Mercury.—The price of mercury, having declined precipitously since 1955, began to increase sharply in the last quarter of the year; however, the price increase, from about $190 per 76-pound flask in September to $240–$244 per flask at the end of December, did not bring forth any immediate new activity. A very small quantity of mercury was produced at a small prospect in Grant County; a total of 9,043 flasks were produced in the peak year, 1940.

A $63,000 exploration contract remained active between the Office of Minerals Exploration and Pacific Minerals and Chemical Co., Inc., for work on mining properties in Crook County.

The State of Oregon Department of Geology and Mineral Industries published a comprehensive report on mercury resources of the State.[5]

Nickel.—Hanna Mining Co. mined 892,900 dry tons of nickel ore on Nickel Mountain near Riddle, Douglas County, containing an average of 1.5 percent nickel, or a total of 13,394 tons of contained nickel. Hanna Nickel Smelting Co., at the base of the hill below the mine, produced 21.4 million pounds of nickel contained in ferronickel, which was shipped to stainless and other alloy steel producers. The Hanna company reported that demand exceeded production capacity. Bechtel Corp., San Francisco, Calif., was hired to work with Hanna engineers to develop plans for expanding plant capacity. The nickel-smelter energy load drawn from Bonneville Power Administration was increased from 67.1 million to 82.0 million watts by the end of the year. Delivery of an additional 10 million watts in 1964 was contracted between the company and the administration. The additonal load was expected to provide the energy for a 20- to 25-percent increase in ferronickel production.

Ore-reserve estimates by the company placed the life expectancy of the Nickel Mountain deposit at 13 to 15 years, based on the 1962 rate of ore extraction. However, future metallurgical and mining research on mineralized rock in the deposit, of lower grade than that being mined, might develop additional ore tonnage, thereby extending the life of the mine and smelter operation.

Silver.—Silver output climbed significantly from 6,047 ounces in 1962 to 58,234 ounces, the highest production since 1942. Almost all of the increase was attributable to the Oregon King mine, Jefferson County. The only other significant silver-producing mine was the Buffalo, Grant County.

Uranium.—The Lucky Lass mine, Lake County, was operated by

[5] Brooks, Howard C. Quicksilver in Oregon. Oregon Dept. Geol. and Miner. Ind., Bull. 55, 1963, 223 pp.

Lucky Lass Mines, Lakeview. Production of 1,763 tons of ore containing 0.30 percent uranium oxide was shipped to Vitro Chemical Co., Salt Lake City, Utah. The ore was taken from a hole, approximately 35 feet deep, sunk at the bottom of the open-pit mine.

Other Metals.—The metallurgical complex about Albany, Linn County, was active in research, development, and processing of metals such as titanium, tungsten, molybdenum, columbium, vanadium, zirconium, and hafnium. The Federal Bureau of Mines Albany Metallurgy Research Center, Wah Chang Corp., Oregon Metallurgical Corp., and Northwest Industries, Inc., comprised the Government and industry operations in the area.

MINERAL FUELS

Petroleum.[6]—The Oregon Department of Geology and Mineral Industries issued two drilling permits for oil and gas tests, compared with six permits in 1962. Footage drilled totaled 13,837 feet. A permit authorizing reentry of an oil test hole, which was drilled in Polk County by Reserve Oil & Gas Co. in 1960, was issued to M. C. Lewis. E. M. Warren & Associates, San Antonio, Tex., drilled a 6,300-foot test well in Coos County. Gulf Oil Corp. started a test well in October, 3½ miles north of Halsey in the central Willamette Valley. The well was abandoned in January 1964, after reaching a depth of 8,471 feet. (1963 footage drilled was 7,537 feet.)

Four major oil firms were active offshore during the summer and fall. Conventional seismic, aeromagnetic, and sparker surveys along with intermittent bottom sampling and core drilling, were conducted on Oregon's continental shelf. Shell Oil Co. has been the most active company in the area since it began exploration work in 1961, participating in an aeromagnetic survey and conducting conventional seismic exploration from four boats and core drilling from a fifth boat during the past season. Richfield Oil Corp., the newest company in the area, began exploratory sparker surveys in August. The company contracted a Los Angeles firm for core drilling. Union Oil Co. and Standard Oil Co. of California conducted a joint bottom-sampling program, using a contracted core boat from Santa Barbara, Calif. Union Oil Co. made sparker surveys in 1961 and took bottom samples of the ocean floor in 1962. Standard Oil Co. of California participated in an aeromagnetic survey and conducted seismic surveys from June until August, contracting a Houston, Tex., firm for the seismic exploration. Superior Oil Co., performing limited exploration in 1962, did not resume work during the year. Gulf Oil Co. had obtained an exploration permit in 1961, but let it lapse at the end of the year.

During exploration, companies were not required to file their findings with any State agency; however, they were required to report all oil or gas shows to the Oregon Department of Geology and Mineral Industries. None were reported.

To prevent releasing a reserve of high-pressure gas, a 1,000-foot depth limitation was placed on drilling for core samples, which were drilled open hole with no casing. The 1,000-foot limit on core drilling was established by using the shallowest onshore gas show recorded,

[6] Oil-well drilling data were obtained from the Ore Bin, a monthly publication of the Oregon Department of Geology and Mineral Industries.

which was from a well drilled near Coos Bay in the 1940's at a depth of 1,100 feet.

The first leasing by the Federal Government of offshore lands (lying beyond the State 3-mile limits) in the Pacific Northwest was announced in August when the Department of the Interior called for nominations of areas for prospective oil and gas leasing on the outer Continental Shelf off Oregon and Washington. By calling for nominations, the first formal step in leasing procedure, the Department of the Interior requested oil firms to indicate areas of interest. This enabled the Bureau of Land Management to select areas that would be subject to sealed bid. Nominations for Federal offshore tracts were to be submitted to the Director, Bureau of Land Management, by November 1. Sealed bids on specific Federal tracts by oil firms were to be called for by the Department of the Interior by October 1, 1964.

The Oregon State Land Board started platting a lease map covering State-owned tide and submerged lands and was studying the procedure for giving public notice and accepting bids. It was anticipated that interest would be shown in State lands when the Bureau of Land Management announced the Federal areas to be offered for lease.

Oregon petroleum exploration areas were considered in two reports.[7]

REVIEW BY COUNTIES

Mineral production was reported from all 36 counties in 1963. With certain important exceptions, output was principally from nonmetallic deposits. Only selected counties with significant metal and nonmetal developments are discussed in the following review.

Baker.—Oregon Portland Cement Co. continued to supply the predominant value to the county mineral industry. Limestone for the cement plant and for industrial and agricultural purposes was supplied from the Durkee quarry; shale for manufacturing cement was obtained from the company Gales Creek quarry.

Chemical Lime Co. operated a lime-manufacturing plant at Baker; limestone obtained from the company Marble Creek quarry northwest of Baker was calcined and processed to quicklime and hydrated lime.

The company completed a diamond-drilling program on a limestone occurrence at the head of Baboon Creek in the Elkhorn Mountains. Crushing started in October at the location, which is approximately 2½ miles west of the company's Marble Creek quarry.

Output of limestone increased because more cement and lime were used by the construction industry.

Clackamas.—Output of cement at the Oswego plant of Oregon Portland Cement Co. contributed significantly to ranking the county first in mineral commodity production value. Limestone for the plant was transported by barge from Texada Island, British Columbia. Output of stone nearly doubled because of use of basalt for road construction by the Federal Forest Service.

---

[7] Bryne, John J. Geomorphology of the Continental Terrace Off the Northern Coast of Oregon. Ore Bin, v. 25, No. 12, 1963, pp. 207–209.
Newton, V. C. Jr., and R. E. Corcoran. Petroleum Geology of the Western Snake River Basin Oregon-Idaho. Oregon Dept. of Geol. and Miner. Ind., Oil and Gas Investigations, Rept. 1, 1963.

TABLE 12.—Value of mineral production in Oregon, by counties

(Thousand dollars)

County	1962	1963	Minerals produced in 1963 in order of value
Baker	$4,028	$5,822	Cement, stone, lime, clays, sand and gravel, gold, silver.
Benton	318	423	Sand and gravel, stone, clays.
Clackamas	6,242	7,488	Cement, sand and gravel, stone, clays.
Clatsop	504	211	Stone, sand and gravel.
Columbia	219	366	Stone, sand and gravel, pumice, iron ore (pigment material).
Coos	613	808	Stone, sand and gravel.
Crook	101	107	Sand and gravel, clays, stone.
Curry	201	2	Sand and gravel.
Deschutes	528	819	Pumice, sand and gravel, stone.
Douglas	7,912	9,531	Nickel, stone, sand and gravel.
Gilliam	748	1,180	Stone, sand and gravel.
Grant	134	428	Stone, sand and gravel, gold, silver, copper, lead, mercury, zinc.
Harney	261	284	Sand and gravel, stone, pumice.
Hood River	487	886	Stone, sand and gravel.
Jackson	4,423	4,949	Cement, sand and gravel, stone, clays, pumice, gold, zinc, silver, lead.
Jefferson	192	974	Stone, sand and gravel, silver, gold, copper, lead, zinc.
Josephine	470	237	Stone, sand and gravel, gold, silver.
Klamath	738	1,379	Stone, sand and gravel, pumice, clays.
Lake	235	90	Uranium, stone, diatomite, sand and gravel.
Lane	10,049	7,310	Stone, sand and gravel.
Lincoln	460	692	Do.
Linn	1,062	1,458	Sand and gravel, stone.
Malheur	991	796	Lime, sand and gravel, stone, gold, silver.
Marion	576	688	Sand and gravel, stone.
Morrow	71	[1]	Do.
Multnomah	3,194	5,043	Sand and gravel, stone, lime, clays.
Polk	475	489	Stone, sand and gravel, clays.
Sherman	76	2,058	Stone, sand and gravel.
Tillamook	1,053	522	Sand and gravel, stone, clays.
Umatilla	1,286	1,332	Stone, sand and gravel.
Union	507	378	Do.
Wallowa	269	[1]	Do.
Wasco	664	1,087	Do.
Washington	598	689	Stone, clays.
Wheeler	126	126	Stone.
Yamhill	373	706	Stone, sand and gravel, clays.
Undistributed [2]	2,274	3,334	Stone, sand and gravel, gem stones, pumice, copper, silver.
Total	52,458	62,692	

[1] Figure withheld to avoid disclosing individual company data; included with "Undistributed."
[2] Includes value of mineral production that cannot be assigned to specific counties and values indicated by footnote 1.

Clatsop.—As a result of an economic study made for Pacific Power and Light Co. by the Arthur D. Little Co. consulting firm, the power company's research and development department interested the Bunker Hill Co. of Idaho in making an exploration-drilling examination of an area of beach sands, approximately 2 miles wide by 5 miles long, in the Clatsop Spit-Camp Rilea region. (See Metals—Iron Ore.) The objective of the exploration was to determine the iron content (magnetite sand) of the lands adjacent to the beach fronting on the Pacific Ocean. The drilling program, employing a crew of about 20, was expected to require 7 to 8 months for completion. (The drilling was begun late in the summer.) A jet drill was being used to penetrate some 80 feet into the beach sands, which have a maximum depth of about 100 feet.

Restoration of the land after dredging was incorporated into the lease agreements between the company, Clatsop County, and the State of Oregon. Some of the area involved was marshy tidal land that could be improved by the mining operation. Beaches immediately adjacent to the waterfront were not included in the area being examined.

Crook.—Central Oregon Bentonite Co. mined bentonitic clay at the Silver Wells operation, 64 miles southeast of Prineville.

Pacific Minerals & Chemical Co., Inc., Olympia, Wash., carried out 760 feet of exploratory churn drilling on the Mother Lode and adjacent mercury properties.

Deschutes.—In the Bend area of central Oregon, pumice and volcanic cinder producers supplied sized and blended aggregate for monolithic concrete and for concrete-block manufacturers. Lump pumice was shipped to the Chicago area for abrasive purposes and to Oregon and California for landscaping stone.

Bentonitic clay from the Silver Wells operation southeast of Prineville was trucked to Bend and ground, sized, dried, and bagged for shipment at the Anderson Mining & Development Co. bentonite processing plant.

Douglas.—The Hanna Mining Co. Nickel Mountain multiple-bench mine (25 faces averaging 20 feet in height and 50 feet in width) was worked the entire year. Nearly 1.5 million tons of crude ore and waste material was handled. Over 12,000 feet of development churn drilling was carried out, and additional mining and haulage units were added to the mine operation. The nearby nickel smelter used 592 million Kilowatt-hours (kw.-hr.) of electric energy (6.4 percent more than in 1962), costing $1.3 million (2.12 mills/kw.-hr.), to produce ferronickel containing an average of 49 percent nickel.

Grant.—L. H. Roba and Bandy Sintay of Canyon Creek Mercury Mines, Canyon City, mined and retorted mercury ore; production was sold to Quicksilver Products Co., San Francisco, Calif. The property, located on the L. L. Williams ranch, was reported to have 400 tons of ore blocked out.

Jim Kinsella drove an adit on a narrow copper vein at the Standard mine and shipped ore assaying 25 percent copper after hand sorting. In addition, values were recovered from a cleanup of the Standard millsite.

Jackson.—Cement output at the Ideal Cement Co. Gold Hill operation remained substantially the same as in 1962. Limestone used at the plant was obtained from the company-owned Marble Mountain quarry, and shale was supplied from the Gold Hill quarry.

Bristol Silica Co. mined quartz at its silica quarry near Gold Hill. The raw material was trucked 4 miles to a screening plant at Gold Hill for sizing before shipment to industrial consumers.

Josephine.—Ideal Cement Co. operated the Marble Mountain quarry to supply limestone for use at the company cement plant at Gold Hill, Jackson County.

Lake.—The Lucky Lass uranium mine was active during the summer; the property was closed for the year in September, but the open pit was being kept pumped clear of water. At the White King uranium mine, Vance Thornburg reportedly was continuing a small amount of development.

Lane.—Output of sand and gravel was 2.7 million tons and stone production totaled 4.3 million tons. The bulk of the sand and gravel (2.6 million tons) was produced by 12 commercial firms from 24 operations; the remainder was Government-and-contractor production. The larger portion of the stone production (3.5 million tons) was used by the U.S. Army Corps of Engineers in dam construction.

747-416—64——58

Pacific Diatomite Corp., Eugene, processed and packaged diatomite from a deposit in Lake County. The company announced plans to construct a perlite popping plant at Eugene to treat ore screened at the Tucker Hill deposit near Paisley, Lake County.

National Metallurgical Co., Springfield, continued to reduce silica rock to silicon metal in two electric-smelting furnaces. The silica raw material was principally quartz shipped from Sierra County, Calif. The company announced that the plant capacity would be increased by about 40 percent through a $500,000 capital improvement program to be initiated in 1964.

Linn.—At Albany, Federal Bureau of Mines research programs included such projects as determining the feasibility of electric-furnace smelting of complex lead-zinc ores, developing various metal alloys and determining their chemical and physical characteristics, and developing and testing means by which to cast and form certain metals into various shapes. Wah Chang Corp. emphasized the production and shaping of zirconium; Oregon Metallurgical Corp. installed new quality-control equipment; and Northwest Industries, Inc., continued to machine and fabricate many of the refractory, reactive, and corrosion-resistant metals produced and cast at the Wah Chang and Oregon Metallurgical plants.

Multnomah.—Owing to greater requirements for sand and gravel in road construction, output was 2.7 million tons, compared with 2.2 million tons in 1962. Stone production increased moderately over the 1962 output. Columbia Brick Works mined clay from a company pit southeast of Gresham; the material was used in manufacturing building brick at the Portland plant.

Limestone barged from Texada Island, British Columbia, was used in making lime by Pacific Carbide & Alloys Co. of Portland. The quicklime was utilized by the firm to manufacture calcium carbide. Canadian-produced limestone was used in manufacturing cement by the Oregon Portland Cement Co. at Oswego.

In April, Ash Grove Lime & Portland Cement Co. began constructing a 250-ton-per-day lime plant at Portland's Rivergate industrial district. The lime plant was to go on stream in 1964 and would utilize limestone brought by barge from Texada Island, British Columbia, to produce quicklime and hydrated lime for the chemical and construction industries. Barge unloading facilities were installed at the waterfront site. Shipments of limestone were stockpiled at the plant site late in the year.

Crude nonmetallic minerals produced in other States were shipped to processing plants in the county. The Flinkote Co., Portland, produced naturally and artificially colored roofing granules.

Union Carbide Corp., Metals Division, at St. Johns, although requiring more electric energy from the Bonneville Power Administration (134.2 million kw.-hr. compared with 116.9 in 1962), experienced continued lack of expansion and unfavorable economic conditions in the markets for manganese and silicon alloy. A technologic shift in welding methods cut into the market for calcium carbide, also produced at the plant. Falling product prices, foreign imports, and comparatively static Western U.S. steel consumption contributed to the ferromanganese and ferrosilicon market conditions. Manga-

nese ore was imported from Africa and other foreign sources; silica was obtained from Pacific Northwest and Western Canada deposits.

Polk.—Limestone was quarried near Dallas by Oregon Portland Cement Co. for use at the company cement plant near Oswego. Monmouth Brick & Tile Co. manufactured draintile from clay mined near Monmouth.

Washington.—Cloverleaf Mines, Ltd., and Empire Lite-Rock, Inc., mined shale from quarries near Vernonia and Banks, respectively.

Empire Lite-Rock, Inc., added a third kiln to its plant at Sunset Tunnel. The company produced a special screened and uncrushed 5/8-inch No. 4 fraction for monolithic concrete. Low absorbency of the kiln-fired pellets made it possible to produce concrete weighing 105 pounds per cubic foot with crushing strengths ranging from 3,500 to 4,000 pounds per square inch.

The Mineral Industry of Pennsylvania

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Pennsylvania Bureau of Topographic and Geologic Survey for collecting information on all minerals except fuels.

By James R. Kerr [1]

THE value of Pennsylvania's mineral industry increased 4 percent in 1963 to $856.9 million, the highest total since 1960. Continued resurgence of the bituminous coal and anthracite industries with a combined increase in value of production of $38.2 million was the prime factor in the upturn of the State's mineral economy. These two commodities comprised 59 percent of the value of the State's 1963 mineral output. Combined shipments of portland and masonry cements were virtually unchanged from those of 1962, but a tight cement market forced price cuts and the value of shipments dropped 8 percent. Production of all metals increased, most notably copper, zinc, and iron ores. A firm market for roadbuilding aggregate held production of paving sand and gravel and crushed stone aggregate at high levels. However, there was a slackened demand for sand and gravel aggregates in construction of both private and public buildings. Production of dimension construction stone also decreased. Clay production increased 11 percent mainly because of increased demand for clay refractories.

Washington County with large production of bituminous coal led in value of mineral production. Other leading counties in descending order of value of production, with their leading commodity given in parentheses are as follows: Northampton (cement), Luzerne (anthracite), Green (bituminous), and Schuylkill (anthracite).

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Legislation and Government Programs.—On July 16 a new bituminous strip mine law was signed into effect. In summary, the law requires that all areas stripped after January 1, 1962, be restored to contour, except in exceptional cases when appeals may be made by the stripper to the Land Reclamation Board, which was created by the law. Ter-

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

race backfilling will be permitted in mountainous terrain, provided the highwall is slanted at an angle no steeper than 45 degrees. Other requirements include a $100 boost in per-acre bonds to $500, a State license for each strip mine owner and strip mine permits for each operation, prefiling of reclamation plans, and maintenance of equipment at an abandoned mine until reclamation work is completed. The definition of abandoned mine was changed to one where operations have been halted for 6 months from the former time limit of 1 year.

A new strip mine law for anthracite also was passed which called for complete backfilling on anthracite pits, rather than the former 100-foot limit, and establishment of a board for enforcement of the new law.

TABLE 1.—Mineral production in Pennsylvania [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	38,463	$127,969	38,316	$118,203
Masonry—thousand 280-pound barrels	2,565	7,105	2,510	6,611
Clays [2]—thousand short tons	2,893	12,815	3,191	14,717
Coal:				
Anthracite—do	16,894	134,094	18,267	153,503
Bituminous—do	65,315	331,298	71,501	350,085
Copper—short tons	[3]	[3]	4,434	2,731
Gem stones	[4]	4	[4]	4
Lime—thousand short tons	1,104	16,647	1,188	17,548
Natural gas—million cubic feet	90,053	24,494	92,657	24,091
Natural gas liquids:				
Natural gasoline—thousand gallons	1,350	75	1,311	78
LP gases—do	1,521	112	1,721	118
Peat—short tons	32,936	369	33,952	339
Petroleum (crude)—thousand 42-gallon barrels	5,302	24,230	[5] 4,963	[5] 22,631
Sand and gravel—thousand short tons	14,419	23,587	14,066	23,539
Stone—do	48,144	82,087	49,536	83,450
Zinc [6] (recoverable content of ores, etc.)—short tons	24,308	5,652	27,389	6,572
Value of items that cannot be disclosed: Clays (kaolin), cobalt, gold, iron ore, mica, pyrites, sericite schist, silver, tripoli, and values indicated by footnote 3		32,966		32,644
Total		[7] 823,504		856,864

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes kaolin; included with "Value of items that cannot be disclosed."
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Weight not recorded.
[5] Preliminary figure.
[6] Recoverable zinc valued at the yearly average price of Prime Western slab zinc, East St. Louis market. Represents value established after transportation, smelting, and manufacturing charges have been added to the value of ore at the mine.
[7] Revised figure.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$1,178,969	1958	$889,040
1953	1,134,570	1959	890,632
1954	990,705	1960	862,002
1955	981,731	1961	838,713
1956	1,105,382	1962	868,551
1957	1,057,845	1963	903,737

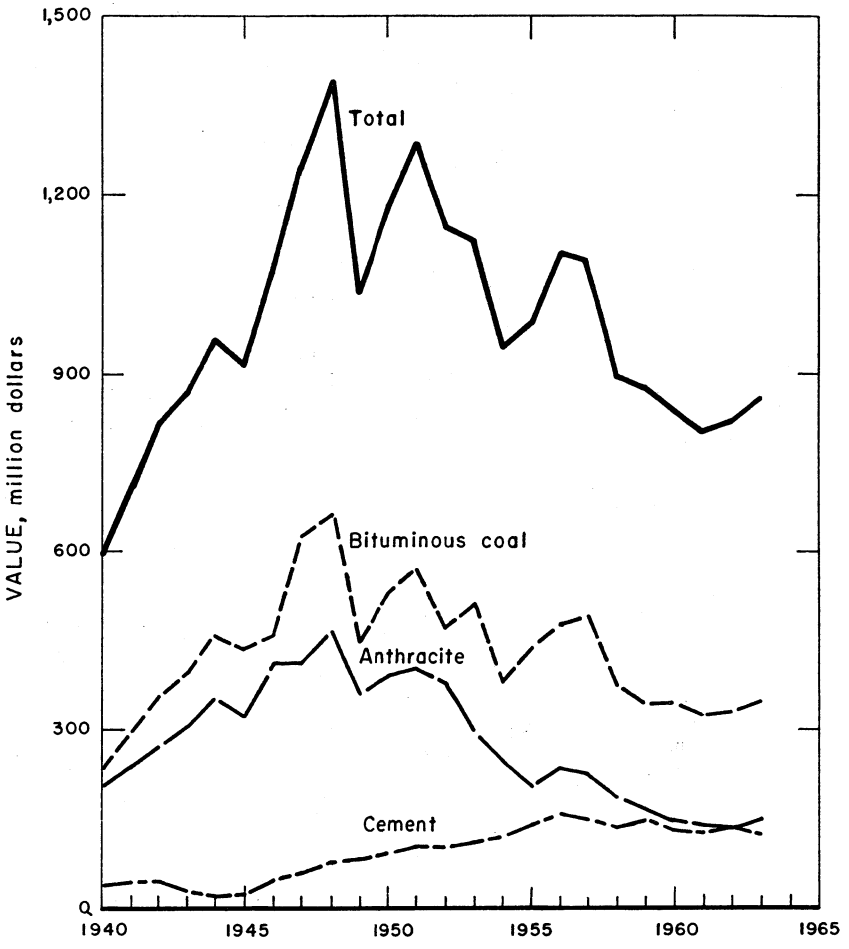


FIGURE 1.—Value of bituminous coal, anthracite, cement, and total value of mineral production in Pennsylvania, 1940–64.

The first project in a new joint State-Federal conservation program was the planned expenditure of $775,000 at Wilkes-Barre to fill in abandoned workings which threaten to cause subsidence damage to a residential area. The new law states that the Federal and State governments share the cost of filling or sealing anthracite mines that threaten public health and safety. Also a part of the program is action to control drainage into anthracite formations.

The Federal Bureau of Mines cooperated with the State under the Accelerated Public Works Program in controlling an anthracite mine fire at Coal Run.

The State Oil and Gas Conservation Commission, Department of Mines and Mineral Industries conducted seven hearings during the year and issued four spacing orders. The Commission established by a 1961 law, has the primary function to control drilling and

plugging of oil and gas wells, exercising particular control over drilling in areas of workable coal seams.

Water.—Almost 93 billion gallons of water was used by Pennsylvania mineral industries in 1962, mainly in mining and processing of metal and nonmetallic minerals, in stone milling, bituminous coal and anthracite washing, and in processing natural gas liquids. In addition, 6.9 billion gallons of water was used in secondary recovery of petroleum, and 30 million gallons was used by petroleum and natural gas well drilling contractors, bringing the total to almost 100 billion gallons. Of total new water used 12.3 billion gallons was fresh (potable) water and 36.8 billion gallons was contaminated. A large quantity (53 billion gallons) of water, after use, was pumped to tailings ponds and after settling, was recirculated, thus reducing new water requirements and averting stream pollution, thereby helping conserve a vital natural resource. Recirculation was especially prevalent in the anthracite and bituminous coal industries. A total of 27.4 billion gallons was treated, the leading methods of which were filtering, pH control, bactericide additions, and chlorination.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Industry	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	11,976	1,291	13,267	11,538	438	145.70
Coal, anthracite	16,938	14,930	31,868	15,585	1,353	128.67
Coal, bituminous	2,682	23,483	26,165	1,914	768	13.47
Metal mines and mills	3,095	6,293	9,388	2,391	704	80.85
Nonmetal mines and mills	25	11	36	25		1.94
Sand and gravel plants	6,996	4,907	11,903	6,615	381	296.60
Natural gas liquids plants	260	81	341	249	11	1,390.65
Total	41,972	50,996	92,968	38,317	3,655	85.99

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Anthracite).—Exports of anthracite, which increased 86 percent, was the leading factor in the 8-percent rise in anthracite production in 1963, reversing a downward trend for the 1st year since 1956. Exports were shipped chiefly to Canada and Western Europe. Consumption of anthracite at coke plants increased 7 percent but retail deliveries, the most important market tonnagewise, decreased 15 percent from that of 1962. Consumption by electric utilities decreased 6 percent. Average prices per ton increased with greater demand rising $0.46 to $8.40.

Of the total production of 18.3 million tons, 78 percent was fresh mined coal, 19 percent was from culm banks, and 3 percent was from river dredges. Of the fresh mined coal, 53 percent was from strip pits; 47 percent from underground mines. Production from dredges, which operated chiefly on the Susquehanna River, was 5 percent less than that of 1962. Of the underground production, 3.7 million tons

(55 percent) was loaded mechanically; the balance was hand loaded. The number of scraper loaders in use increased by 19 to 147, and the tons loaded by this method increased 59 percent. There were 4 fewer mobile loaders in use in 1963, but production by the remaining 30 was slightly greater than in 1962. Twenty-four fewer conveyors (512) including duckbills and self-loading conveyors loaded 12 percent more than in 1962. Rail shipments increased 18 percent to comprise 51 percent of the total. Truck shipments were slightly less than in 1962. Luzerne and Schuylkill were the leading producing counties followed by Northumberland and Lackawanna Counties.

The average number of men working daily dropped by 512 to 13,498. However, because of an increase of 12 days in number of days active, the total labor increased 2 percent to 2.9 million man-days. Total productivity increased to 6.27 from 5.92 tons per man-day. Productivity at dredges was 26.77 tons per man-day, at all other operations 6.09 tons per man-day. Productivity was the greatest in the Lehigh region because of the predominance of strip mining. Fewer men were employed in Schuylkill and Lackawanna Counties, but more were working in Northumberland and Luzerne Counties.

There were 32 fatalities at Pennsylvania anthracite mines in 1963, 6 more than had occurred in 1962. Injury frequency rates were 1.66 per million tons of coal produced and 1.70 per million man-hours of exposure, an increase of 9 percent and 35 percent, respectively. Underground fatalities increased by 9 to 27 in 1963. Falls of roof, face, or rib claimed 13 lives, explosions and explosives accounted for 5 and 3 fatalities, respectively. Surface operations at underground mines reported 2 fatalities, and strip mines reported 3 fatalities.

A spectacular mine rescue was successfully attempted at an underground anthracite mine near Shippton, Pa., where three miners were trapped in a cave-in on August 13. A completely new method of rescue was used, in which a bore hole was drilled to the area of the entrapped miners, the hole enlarged, and two of the men were hoisted to the surface by a harnessing arrangement.

Work continued in the long fight to extinguish burning culm dumps and to reduce acid formation in mining operations. In addition, State programs were active in correcting conditions caused by early mining operations which are detrimental to public welfare. Such programs included sealing mine openings at abandoned underground mines, backfilling abandoned open-pit mines, and extinguishing mine fires.

Coal (Bituminous).—Responding to increased demand by the electric utility market, the State's bituminous coal industry increased production by 9 percent to 71.5 million tons, the highest level since 1957. Captive coal production, however, decreased slightly despite the high rate of steel production, reflecting increasing efficiency in both the production of coke and its consumption in the blast furnace. Continued cost cutting and closing of inefficient mining operations was reflected in decreased values from $5.07 to $4.90 per ton f.o.b. mine.

Of the total production, 65 percent was mined at 592 underground mines, 34 percent at 521 strip mines, and 1 percent at 69 auger mines. There were five more mines active than in 1962. Shipments were 78 percent by rail or water, 20 percent by truck, and the balance by other

means. Captive production comprised 33 percent of total output. Mechanical cleaning plants prepared 62 percent of total production, of which 68 percent was prepared by wet washing methods other than jigs, 17 percent by jigs, and 15 percent by pneumatic methods. Eighty-nine preparation plants were active, two less than in 1962. At 16 of these preparation plants, 4.9 million tons of coal fines were thermally dried. Of the total State production, 55 percent was crushed and 8 percent was treated, chiefly with oil and salt or combinations of the two, for dust allaying and antifreezing purposes.

Of the underground production, 71 percent was mined and loaded by 337 continuous mining machines, a decrease of 18 machines from the number used in 1962. In addition, 28 percent of the underground production was cut by 665 cutting machines. A small quantity was shot from the solid or cut by hand. Coal drilling was by 536 hand-held or post-mounted drills and 50 mobile drills. Roof bolting was accomplished by 236 rotary and 306 percussion drills. Miscellaneous drilling functions were performed with 119 other drills. Underground main line haulage was handled by 1,430 trolley locomotives, 100 battery-powered locomotives, and 28 mother locomotives, over a total of 901.2 miles of main line track and 323.4 miles of working section track. In addition to the track haulage, 403 other conveyors, each an average of 1,599 feet, carried large tonnages. Intermediate underground haulage was by 918 cable reel and 33 battery shuttle cars plus 31 of the smaller shuttle buggies. Mechanical loading was used at 234 of the underground mines and mechanically loaded tonnage comprised 96 percent of the total. Continuous mining machines accounted for 74 percent of this total, and mobile loading machines accounted for 24 percent. There were 277 mobile loaders in use, of which 198 loaded into shuttle cars, 59 operated behind continuous mining machines, 12 loaded into mine cars, and 8 loaded onto conveyors. The balance of the mechanical loading was done by 13 duckbills and 196 hand-loaded face conveyors.

Equipment at the 521 strip mines included 920 power shovels and 420 dragline excavators, most of which were disel powered and less than 3 cubic yards in capacity. However, 15 of this total were the large plus-12-cubic-yard units. In addition, in use were 813 bulldozers, 116 horizontal and 129 vertical overburden drills, 23 carryall scrapers, and 1,582 trucks which averaged 13 tons capacity. At the 69 auger mines, 79 augers were in use serviced by 107 trucks which averaged 14 tons capacity.

There were 22 fatal and 990 nonfatal injuries in the bituminous coal industry in 1963, a reduction of 37 in number of fatals but an increase of 40 in nonfatal injuries. Injury rates were 0.31 fatal and 14.00 nonfatal per million short tons and 0.50 fatal and 22.36 nonfatal per million man-hours of exposure. There was an average of 26,400 men employed, working an average of 208.7 days, a total of 443 million man-hours. This was an increase of 4,700 in average number of men employed and 66 million man-hours over 1962. The State's injury rates were well under the average for the Appalachian field and for the Nation as a whole.

At underground mines 10 men were killed by falls of roof, 1 man by fall of face or rib, and 6 men in haulage accidents. At strip mines

one man was killed by machinery and two by miscellaneous causes. At auger mines one man was killed by machinery and one by miscellaneous causes.

The unit train concept of coal transportation became more of a reality on April 1, 1963, as the Pennsylvania Railroad reduced freight rates up to $1.50 per ton on shipments of not less than 7,000 tons to a single destination.

Plans were announced for constructing a $175 million coal-burning electric generating station in Armstrong County 35 miles northwest of Johnstown. Jersey Central Power & Light Co., Philadelphia Electric Co., and Pennsylvania Power & Light Co. will jointly construct a 1.6-million kilowatt generating plant.

TABLE 4.—Coal (bituminous) production, by counties

(Thousand short tons and thousand dollars)

County	1962		1963	
	Quantity	Value	Quantity	Value
Allegheny	4,843	$27,946	4,436	$23,876
Armstrong	3,524	16,041	4,150	16,420
Beaver	634	2,062	452	1,476
Bedford	354	1,242	317	1,699
Blair	78	320	13	59
Butler	2,227	7,973	1,902	6,964
Cambria	5,885	34,225	6,955	37,575
Cameron	(1)	(1)	68	265
Centre	729	2,765	759	2,547
Clarion	3,492	12,159	3,711	12,717
Clearfield	6,601	24,569	6,890	25,080
Clinton	407	1,513	481	1,588
Elk	457	1,686	673	2,443
Fayette	1,293	6,088	1,560	7,410
Greene	9,128	57,030	9,615	59,373
Huntingdon	30	123	53	180
Indiana	4,822	23,388	5,588	25,968
Jefferson	1,382	4,791	1,802	6,326
Lawrence	651	2,000	897	2,772
Lycoming	39	125	29	115
Mercer	1,125	4,244	982	3,719
Somerset	2,410	9,599	3,120	11,873
Tioga	(1)	(1)	386	1,727
Venango	295	935	678	2,332
Washington	10,926	69,790	12,153	76,836
Westmoreland	3,570	18,971	3,857	19,164
Undistributed [2]	413	1,713	34	181
Total	65,315	331,298	71,501	350,085

[1] Included with "Undistributed."
[2] Includes Bradford and McKean (1963) Counties, and counties indicated by footnote 1.

Coke and Coal Chemicals.—Responding to the expanded needs of an active iron and steel industry, oven-coke production increased 9 percent over that of 1962. Twelve plants were in operation with 3,720 slot ovens, the same as in 1962. Oven-coke production comprised 98 percent of total coke output. Beehive-coke production was slightly less than in 1962; 18 plants had 3,636 ovens in operation, a decrease of 2 plants and 282 ovens from the number in operation in 1962. The State continued to be first ranking in coke production with output comprising 29 percent of the National total and production more than twice that of the next ranking State.

Value of oven-coke production was $227.3 million, an average value of $14.91 per ton at the ovens, a decrease of $1.45 per ton from that

of 1962. Average value of coal carbonized was $8.45, a decrease of $0.37 per ton from that of 1962. Beehive coke was valued at an average of $13.99, an increase of $0.32 per ton from that of 1962.

To produce 15.2 million tons of oven-coke, 21.9 million tons of coal was carbonized, a yield of 69.6 percent. To produce 1 ton of coke, 1.44 tons of coal was required. Yield of coke from coal at beehive ovens was 61.5 percent. Production figures by State of the coal carbonized at oven-coke plants are as follows: 53 percent was produced within the State (chiefly in the Pittsburgh field), 40 percent originated in West Virginia, 6 percent in Virginia, and 1 percent in Kentucky. Most of the coal was high volatile (72 percent), low volatile (20 percent), and medium volatile (8 percent).

Coke production was consumed mainly (98 percent) in blast-furnace plants within the State. Heating units at coke plants used 39 percent of the coke-oven gas produced. Steel or allied plants used 82 percent of the remainder, 15 percent was used under boilers, and the balance was sold. Coke breeze was consumed chiefly in agglomerating plants (74 percent) and in steamplants (16 percent). The balance was used for other industrial applications or was sold.

Recovered products at the oven-coke plants included 739,536 tons of coke breeze (a yield of 3.38 percent per ton of coal), 232.0 billion cubic feet of coke-oven gas, 212,246 tons of ammonium sulfate equivalent, 209.4 million gallons of coke-oven tar, 65.6 million gallons of crude light oil (from which was derived 36.6 million gallons of benzene), 9.5 million gallons of toluene, 3.2 million gallons of xylene, and 2.2 million gallons of solvent naphtha (crude and refined).

Peat.—Sharply reduced selling prices characterized the peat industry in the State in 1963. Average value per ton of sales dropped $1.22 to $9.97. Production which was 36 percent greater than that of 1962 was reported by seven producers in five counties. Luzerne and Wayne Counties were the leading peat-producing areas. Moss, humus, and reed-sedge peat was mined, processed, and sold both in bulk and in packaged units. According to the Federal Geological Survey, reserves of peat at the 332 acres of active operations was 1,575,400 tons.

Petroleum and Natural Gas.—Despite increased drilling activity, the production of crude petroleum decreased from 5.3 to 5.0 million barrels, valued at $22.6 million. Natural gas production, however, increased from 90.0 billion to 92.7 billion cubic feet, valued at $24.1 million. Petroleum prices remained at virtually the 1962 rates, but average prices for natural gas decreased 4 percent in 1963.

There were 700 new wells drilled and 26 wells deepened in 1963; 672 were in proven fields and 28 were exploratory tests. There was a total of 205 wells for secondary-recovery projects, 6 were gas storage wells, 210 were gas wells, 198 were oil wells, and 81 were dry holes. The total footage drilled during the year was 1,727,051 feet.

Exploration resulted in discovery of three new gas fields, one new gas pool, and four successful deeper pools. Exploratory drilling totaled 166,388 feet of hole. Eight of the 28 exploratory wells were successful and 20 were dry.

During the year, 109 deep wells (Middle Devonian or older) were drilled, bringing the total number of deep wells to 2,413. Of these,

1,375 were gas wells, 6 were oil and gas wells, 955 were dry holes, 75 were for gas storage, and 2 were for waste disposal. Of the 109 deep wells, 34 were Oriskany gas wells, 32 were Medina gas wells, 40 were dry holes, 2 were gas storage, and 1 was for waste disposal. Total footage was 631,838 feet, an average of 5,797 feet per well. Ninety of the deep tests were drilled with rotary tools, the remaining 19 with cable tools. Crawford County in northwestern Pennsylvania had the greatest density of deep drilling with 24 completions; Indiana County was second with 18 deep wells.

Shallow-sand development (Upper Devonian and younger) accounted for the drilling of 617 holes in 1963 (15 more than 1962), in the following categories: 205 wells for secondary recovery, 3 gas wells for storage, 144 wells for gas, 198 wells for oil, 42 dry holes, and 25 wells drilled deeper. Of the 25 holes drilled deeper, 22 were gas wells, 2 were oil wells, and one was a dry hole. Including the deepened holes, the shallow-sand wells averaged 1,775 feet per well. One hundred and twenty-two of the 144 gas wells were subjected to reservoir stimulation which in some cases increased the initial open flow potential as much as 1,400 percent. Average initial open-flow potential of shallow gas wells was 509,000 cubic feet per day. Of the 198 new oil wells, the average daily production was 61 barrels, largely because of the relatively high initial potentials of wells drilled in the Youngsville-Sugar Grove area, Warren County, where fracturing of the Glade sand has been very successful. No new shallow-sand gas fields or pools were discovered in 1963. Shallow well completions in 1963 were centered in Warren County which had 162 completions of which 151 were oil, 3 were gas, and 8 were dry holes. Indiana County was a distant second with 62 completions. Other significant shallow-well activity was in Armstrong (29 completions), Venango (28), Westmoreland (25), and Clarion (20).

There were 198 new oil wells completed in 1963, a sharp increase over the 97 new oil wells drilled in 1962 and the 43 drilled in 1961. This resurgence in oil well drilling activity was mainly attributed to successful results of new and improved completion techniques such as notching and hydrofracturing. Daily oil production from an estimated 54,023 wells (1,406 less than in 1962) averaged 13,737 barrels, about 0.25 barrel per well per day, a decrease of 4 percent below 1962. The Pennsylvania portion of the Bradford field (86 percent of the field area) produced 66 percent of total State production. Daily oil production from the middle and southwestern districts increased 19 percent over that of 1962. This increase was due to the development of the Youngsville-Sugar Grove area, Warren County, where fracturing has been successfully applied to the Glade sand.

The 144 new gas wells drilled (137 in 1962) had a 9 percent increase in total initial open-flow capacity over that of 1962. The greatest gas well drilling activity was in Indiana County with 58 wells. Armstrong County had 27, Westmoreland 18, and Clarion 14. One of the more significant deep gas well completions was one at 7,710 feet in Westmoreland County.[2]

[2] Lytle, William S. Oil and Gas Developments in Pennsylvania in 1963. Bull. of the Am. Assoc. of Petro. Geol., v. 48, No. 8, June 1964, pp. 784–800.

According to the American Petroleum Institute and the American Gas Association, proved recoverable reserves of crude oil were 91,734,000 barrels and reserves of natural gas were 1,214 billion cubic feet as of December 31, 1963. Of the natural gas reserve, 491 billion cubic feet was in underground storage. Pennsylvania has an estimated storage capacity of 658 billion cubic feet, or an estimated 17 percent of the U.S. total. Storage of natural gas is accomplished by 10 operating companies in 56 fields or areas scattered through 14 or more counties.[3]

As of January 1, 1963, Pennsylvania had a total of 13 refineries with a crude capacity of 675,000 barrels per calendar day producing a full range of petroleum products except coke.

Natural Gas Liquids.—Production of liquefied petroleum gases increased 13 percent to 1.7 million gallons, but output of natural gasoline decreased 3 percent to 1.3 million gallons. Average prices per gallon for natural gasoline were up to $0.059 from $0.056 in 1962, but for liquefied petroleum gases average prices per gallon dropped from $0.074 in 1962 to $0.069 in 1963.

According to the American Gas Association, total reserves of natural gas liquids including condensate, natural gasoline, and liquefied petroleum gases as of December 31, 1963, were 1.4 million barrels.

NONMETALS

Cement.—Tight markets and depressed prices for cement, particularly along the eastern seaboard, characterized the cement industry in 1963. The industry operated at 71 percent of capacity, and the production of portland cement was at virtually the same rate as in 1962. However, the value of production decreased 8 percent as average prices dropped $0.25 to $3.08 per barrel. Masonry cement output was 2 percent less than in 1962, but value of production was down 7 percent as price cuts also were in effect for masonry cement.

Overly abundant supplies of cement saturated the markets along the eastern seaboard because of increased shipments from a large-capacity new plant in the East. Price cuts and extended time allowances for cash sales were two of the steps taken by cement manufacturers to retain customers. This was particularly true for eastern counties where most of the price reductions were in effect. The western counties were virtually unaffected. A new labor contract with increased wages and improved pension and insurance benefits went into effect for most of the industry on May 1, 1963.

There were 22 cement plants with 106 rotary kilns active, of which 14 used the dry process (65 percent of capacity), 7 used the wet process, and 1 had a combination of both. Of total energy requirements, 199.4 million kilowatt hours was generated by the cement companies and 753.8 million kilowatt hours was purchased. Stocks of portland cement decreased from 6.04 to 5.84 million barrels.

Cement rock and limestone were the chief raw materials for cement manufacture, totaling 10.9 million tons and comprising 91 percent of total requirements. Other raw materials included gypsum (309,668 tons), slag (225,901 tons), sand (210,579 tons), and shale and clay

[3] Oil and Gas Journal, v. 62, No. 14, Apr. 6, 1964, pp. 131–132.

(198,422 tons). Smaller quantities of carbon black, iron materials, sludge, air-entraining compounds and grinding aids also were required.

Portland cement shipments were to consumers in 45 States and several foreign countries. Pennsylvania consumed 36 percent of its own production. Shipments to other large consuming States were New Jersey (22 percent), New York (15 percent), Ohio (7 percent), Connecticut (5 percent), and Maryland (4 percent). Masonry cement was shipped to consumers in 24 States and several foreign countries. The State consumed 36 percent of its output and New Jersey received 20 percent; New York, 16 percent; and Ohio, 12 percent.

Distribution of portland cement shipments were to ready-mixed concrete companies (55 percent), concrete product manufacturers (20 percent), building-material dealers (12 percent), highway contractors (9 percent), other contractors (2 percent), and Government and miscellaneous customers (2 percent).

TABLE 5.—Portland cement shipments, by counties

County	Number of plants in 1963	1962		1963	
		376-pound barrels	Value	376-pound barrels	Value
Lehigh	4	6,580,842	$21,041,268	6,566,840	$18,954,773
Northampton	11	19,324,721	63,525,400	18,816,439	56,104,232
Allegheny	2	6,397,052	21,250,020	6,714,204	21,995,863
Lawrence	2				
Berks	1	6,160,200	22,152,731	6,218,726	21,147,992
Butler	1				
Montgomery	1				
York	1				
Total	23	38,462,815	127,969,419	38,316,209	118,202,860

Clays.—Increased production of clay refractories to meet the vigorous demand of the steel industry and generally increased construction activity resulted in an 11 percent increase in clay production following 2 successive years of declining output. Consumption of fire clay, chiefly for firebrick and block,increased 18 percent. Production of miscellaneous clay, chiefly for use in manufacturing heavy clay products, cement, and lightweight aggregate, also increased in 1963. Kaolin output increased 39 percent, chiefly because of greater demand for its use in white cement manufacture. There were 117 clay operations active in 1963, 9 less than in 1962. Of these, 94 were open-pit mines, 19 were underground, and 4 were mills only. Sixty-seven clay mills served these mines. Clearfield County with large production of fire clay was the leading clay-producing area. Leading fire clay-producing counties, valuewise, were Clearfield, Armstrong, and Jefferson. Leading miscellaneous clay-producing counties were Berks, Northumberland, and Dauphin. Kaolin was mined in Cumberland and Blair Counties.

Gem Stones.—Mineral specimens were collected chiefly by hobbyists and amateur lapidarists in the eastern part of the State, particularly the counties of Chester, Lehigh, Monroe, and Montgomery. Specimens included pyromorphite, limonite crystals, zeolites, quartz, calcite, copper and lead minerals, and semiprecious agates.

TABLE 6.—Clays sold or used by producers, by kinds and uses[1]

(Short tons)

Use	Fire clay		Miscellaneous clay	
	1962	1963	1962	1963
Refractories:				
Firebrick and block	611,313	783,272		
Fire clay mortar	13,253	20,672		
Clay crucibles	2,012	(2)		
Foundries and steelworks	57,157	(2)	(2)	(2)
Heavy clay products	516,826	557,945	1,246,641	1,267,538
Portland and other hydraulic cements			(2)	199,275
Undistributed	[3] 75,584	[3] 142,681	[4] 370,676	[4] 219,222
Total	1,276,145	1,504,570	1,617,317	1,686,035

[1] Excludes kaolin.
[2] Included with "Undistributed" to avoid disclosing individual company confidential data.
[3] Includes floor and wall tile (1963), high-alumina brick, glass refractories (1962), other refractories, rubber, paint (1963), insecticides and fungicides, other filler (1963), absorbent uses (1963), other uses (1963), and items indicated by footnote 2.
[4] Art pottery, flowerpots and glaze slip, foundries and steelworks, lightweight aggregate, linoleum and oilcloth, other uses, and items indicated by footnote 2.

TABLE 7.—Clays sold or used by producers in 1963, by counties

County	Short tons	Value	Types of clay
Adams	75,450	$37,950	Miscellaneous clay.
Allegheny	99,452	(1)	Do.
Armstrong	205,562	1,778,368	Fire clay, miscellaneous clay.
Beaver	113,828	994,655	Do.
Bucks	56,000	56,000	Miscellaneous clay.
Butler	10,744	16,100	Do.
Chester	98,726	123,500	Do.
Clarion	78,255	334,678	Fire clay, miscellaneous clay.
Clearfield	465,219	3,304,834	Do.
Columbia	12,267	22,080	Miscellaneous clay.
Fayette	101,789	542,315	Fire clay, miscellaneous clay.
Lawrence	430,211	618,102	Do.
Luzerne	30,000	27,000	Miscellaneous clay.
Montgomery	57,682	97,682	Do.
Snyder	5,775	7,219	Do.
Washington	569	569	Fire clay.
Undistributed [2]	1,349,076	6,756,178	
Total [3]	3,190,605	14,717,230	

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes Berks, Blair, Cambria, Centre, Clinton, Cumberland, Dauphin, Huntingdon, Indiana, Jefferson, Lancaster, McKean, Monroe, Northumberland, Schuylkill, Somerset, and York Counties, and counties indicated by footnote 1.
[3] Incomplete total; excludes kaolin produced in Blair and Cumberland Counties.

Graphite.—The natural graphite operation at Chester Springs in Chester County, where crystalline graphite had been recovered from schist, was closed for the 2d successive year. However, manufactured (artificial) graphite powder was produced in Saint Marys by electric graphetizing a carbon product. Sales, chiefly to steel producers, iron and steel foundries, and the electro-chemical industry, were 12 percent greater than those in 1962.

Iron Oxide Pigments.—Sulfur mud from Cambria County and red iron oxide mud residue from past alumina extraction processes in Allegheny County were the only crude iron oxide pigments produced in the State.

Pennsylvania continued as the first ranking State in output of natural and manufactured iron oxide pigments. Output was 7 per-

cent greater than in 1962. Manufactured red iron oxides including the pure calcined copperas were the leading types produced. Manufactured yellow iron oxide (pure), natural brown oxide, burnt umber, manufactured magnetic black (pure), and burnt sienna also had important sales. One producer was active in Carbon County and two plants were operated in Northampton County.

Lime.—Vigorous demand for chemical lime by the steel industry and the pulp and paper industry, and increased refractory lime markets, highlighted a good year for the lime industry as production increased 8 percent. The construction industry consumed slightly more lime, but aglime sales were 5 percent less than in 1962. Sales of hydrated lime were 18 percent less, but the decrease was offset by a 21 percent increase in quicklime sales. Quicklime production comprised 75 percent of output in 1963, an increase from 67 percent in 1962. Average value of lime per ton production decreased $0.31 to $14.77 in 1963. Regenerated lime was one-third less than in 1962. Lime burning capacity of active producers exceeded 1.8 million tons. A variety of kilns were in use, but the bulk of capacity was from 23 rotary kilns which were fired chiefly with bituminous coal.

Fifteen companies, 1 less than in 1962, operated 8 plants in 15 counties. Centre County continued to be the leader, producing 48 percent of the State lime shipments. York, Lebanon, Chester, Butler, and Montgomery Counties were next in decreasing order, each with lime production valued in excess of $1 million. Most of the lime was consumed within the State (59 percent), but large quantities were shipped to Maryland (9 percent), New York (8 percent), New Jersey (7 percent), and Ohio (5 percent).

TABLE 8.—Lime sold by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Armstrong	(1)	(1)	327	$4,905
Centre	502,752	$6,732,596	576,346	7,577,065
Dauphin	8,000	128,000	7,500	120,000
Juniata	1,482	15,190	(1)	(1)
Lancaster	841	10,077	(1)	(1)
Lebanon	137,000	1,998,000	150,000	2,182,000
Northumberland	337	3,031	325	2,925
Snyder	1,135	9,202	(1)	(1)
Undistributed [2]	452,009	7,750,806	453,719	7,661,045
Total	1,103,556	16,646,902	1,188,217	17,547,940

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes Bedford, Butler, Chester, Mifflin, Montgomery, Westmoreland (1963), and York Counties and counties indicated by footnote 1.

Magnesium Compounds.—The magnesium carbonate plant at Plymouth Meeting which used raw dolomite as raw material was closed at the end of 1962. The company reported unprofitable operations.

Mica.—Scrap mica recovered near Glenville in York County was ground and sold chiefly to the paint and rubber industries and for welding rods. Output was slightly higher in 1963.

Perlite (Expanded).—Crude perlite shipped from Colorado was expanded at six plants in Allegheny, Lehigh, Delaware, York, and Mont-

gomery Counties. Production was 14,017 tons, 2 percent less than that of 1962. Average value dropped $5.00 to $60.00 per ton. Sales were mostly to contractors for use as lightweight aggregate in building plaster. Other markets included filler, loose fill insulation, concrete aggregate, insulation, and soil conditioning.

Pyrites.—Pyrite, contained in the iron ores mined in Lebanon and Berks Counties, was separated by flotation in the milling process, concentrated, and shipped to a sulfuric acid plant at the iron and steel complex at Sparrows Point, Md. Consumption of pyrites was less than that in 1962, but because of higher sulfur content of the concentrates, total sulfur consumed was greater in 1963.

Sand and Gravel.—A depressed market for construction sand was the chief factor in a 2-percent drop in overall sand and gravel production. Decreased production of paving and building sand, 10 and 5 percent, respectively, was only partially offset by a 17-percent increase in output of building gravel. Glass sand and ground sand production were at their highest levels since 1946 and 1947, respectively. There were 117 sand and gravel pits active in 45 counties of which 101 had stationary plants, 11 were dredges, 3 had portable plants, and 2 produced only bank-run material. Eighty-five of the pits produced less than 100,000 tons, and only one had production in excess of 1 million tons. Aggregate for use in construction of both private and public buildings was the leading market, consuming 51 percent of total sand and gravel production; paving aggregate consumed 33 percent. Although production of industrial sands (including glass sand) and ground sand comprised only a small fraction of total output, the high prices of these specialty sands brought the value of their production to comprise over one-fifth of total value.

Bucks County, the leading sand and gravel producing area, had a major decrease in production with output 23 percent less than in 1962. Other large producing counties, listed in order of decreasing value of production, were Huntingdon, Armstrong, Erie, Mifflin, and Beaver, each with production valued at over $1 million. Industrial sand production was centered in Huntingdon and Mifflin Counties, but the former county had the entire output of ground sand. Government-and-contractor production was reported in Clearfield and Crawford Counties for paving and road maintenance.

As in 1962, 98 percent of total production was washed, screened, or otherwise prepared. Of total shipments, 67 percent was by truck, 26 percent by waterway, and 7 percent by railroad.

Stone.—Output of stone increased 3 percent but total value of production increased only slightly. This was because the increased output was in lower priced crushed stone chiefly for the aggregate market which was characterized by price cutting in 1963. Dimension stone production decreased 6 percent, but value of production increased 11 percent chiefly because of higher prices for dimension slate and sandstone. Quarries were active in 51 counties, yielding almost 50 million tons. Leading producing counties, valuewise, were Northampton, Montgomery, York, Adams, and Bucks, all with production valued over $5 million.

Limestone was the leading stone comprising 85 percent of total tonnage. Production increased slightly chiefly because of a 5-percent

TABLE 9.—Sand and gravel sold or used by producers, by classes of operations, and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Molding	141	$405	122	$378
Building	4,493	6,511	4,261	6,301
Paving	2,562	3,777	2,298	3,188
Fire or furnace	169	386	168	382
Fill	31	30	39	29
Undistributed [1]	1,529	4,762	1,533	4,914
Total	8,925	15,871	8,421	15,192
Gravel:				
Building	2,510	3,433	2,931	4,313
Paving	2,748	4,070	2,278	3,666
Fill	130	83	153	89
Undistributed [2]	106	130	206	228
Total	5,494	7,716	5,568	8,296
Total sand and gravel	14,419	23,587	13,989	23,488
Government-and-contractor operations:				
Sand: Other			27	33
Gravel: Paving			50	18
Total sand and gravel			77	51
All operations:				
Sand	8,925	15,871	8,448	15,225
Gravel	5,494	7,716	5,618	8,314
Total	14,419	23,587	14,066	23,539

[1] Includes glass, grinding and polishing, blast, engine, filter (1963), railroad ballast (1963), ferrosilicon (1962), ground, and other sand.
[2] Includes railroad ballast, miscellaneous, and other gravel.

increase in output of crushed limestone for concrete aggregate and roadstone. More limestone was needed as flux by the iron and steel industry, but no refractory dolomite was produced in 1963. Output of limestone for cement manufacture dropped 6 percent but increased limestone production for lime, whiting, and dust for coal mines partially offset this loss. Dimension limestone production used solely for rough construction was less than half that of 1962. There were 158 quarries active in 38 counties, the larger of which were in Northampton, Lancaster, York, and Montgomery.

Production of crushed sandstone increased 44 percent, but total value was less that that of 1962 as the average value per ton dropped from $3.16 to $2.17. The reason was sharply increased output for aggregate and decreased production of refractory stone due to the idling of a major quarry in Huntingdon County in 1963. Crushed sandstone was produced at 34 quarries in 21 counties with Westmoreland and Luzerne leading. Value of dimension sandstone production rose 43 percent owing to a large increase in production of flagging and a moderate increase in output of rough construction building stone. Rough architectural stone output decreased slightly. There were 37 sandstone quarries active in 14 counties; Potter and Chester Counties led. Average value per ton of dimension sandstone production increased to $12.66 from $9.91 in 1962.

TABLE 10.—Sand and gravel sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Allegheny	210,362	$370,714	234,248	$398,769
Armstrong	1,208,969	2,492,159	1,416,425	3,102,702
Beaver	(1)	(1)	774,694	1,064,837
Bedford	(1)	(1)	6,748	18,148
Berks	85,544	141,789	58,950	85,762
Bradford	(1)	(1)	112,516	140,000
Butler	135,246	166,110	149,016	202,306
Carbon	217,553	314,953	(1)	(1)
Clearfield			26,858	32,827
Crawford	(1)	(1)	113,734	132,924
Cumberland	222,370	326,490	212,247	309,237
Erie	(1)	(1)	1,400,666	1,988,157
Fayette	162,000	349,000	60,000	131,500
Jefferson	9,000	3,600	(1)	(1)
Lackawanna	186,348	189,851	233,802	236,697
Lancaster	206,016	360,020	204,595	383,655
Luzerne	433,309	522,928	464,859	547,970
McKean	(1)	(1)	10,000	10,000
Mercer	222,887	293,684	322,557	448,827
Monroe	77,688	84,980	(1)	(1)
Montgomery	(1)	(1)	590	13,676
Northampton	461,270	550,396	448,603	550,860
Schuylkill	91,482	220,719	121,803	257,964
Snyder	(1)	(1)	128,325	134,058
Somerset	850	2,680	(1)	(1)
Warren	156,091	226,253	209,892	318,767
Wayne	(1)	(1)	16,639	23,030
Undistributed [2]	10,331,537	16,970,309	7,338,050	13,006,508
Total	14,418,522	23,586,635	14,065,816	23,539,181

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes Blair, Bucks, Cambria, Clarion, Columbia, Dauphin, Elk, Forest, Franklin, Fulton, Huntingdon, Lawrence, Lehigh (1962), Lycoming, Mifflin, Montour, Philadelphia, Venango, Wyoming, and York Counties, and counties indicated by footnote 1.

Increased production of higher-priced structural and sanitary slate for blackboards and roofing, resulted in slightly increased value of dimension slate production even though slate output dropped 8 percent in 1963. Crushed slate production, which increased 12 percent, also had increased prices. Production was chiefly from Northampton County.

Production of crushed basalt was less as its major market (aggregate) was depressed. Other stone aggregates and gravel presented stiff competition. Basalt production for railroad ballast also decreased in 1963. Twenty-two quarries were active in seven counties, of which Delaware and Adams were the leading.

Crushed miscellaneous stone production which was used entirely as concrete aggregate and roadstone increased 9 percent. Production which was centered in Montgomery and Bucks Counties consisted entirely of argillite. A small quantity of mica schist dimension stone also was produced.

Crushed granite production which was used entirely for aggregate was produced at a rate 22 percent higher than in 1962. Quarries were located in Bucks and Montgomery Counties. Small quantities of dimension granite were produced in Bucks and Montgomery Counties for rough and dressed construction uses. Oystershell was produced for poultry grit in Berks County.

Roofing granules production dropped in 1963 because of reduced sales of artificially colored granules. Of total production, 81 percent

was artificially colored; the balance was natural material. Three plants were active, one each in Adams, York, and Beaver Counties. Slate, basalt, and clay were the raw materials used in roofing granules production.

TABLE 11.—Stone sold or used by producers, by uses

Use	1962		1963	
	Short tons	Value	Short tons	Value
Dimension stone:				
Building stone	146,721	$1,232,061	132,623	$1,324,393
Curbing and flagging	[1] 36,864	[1] 739,879	38,604	884,090
Other uses	[1] 28,581	[1] 3,232,982	29,152	3,548,153
Total	212,166	5,204,922	200,379	5,756,636
Crushed and broken stone:				
Concrete and roadstone	26,471,466	39,184,889	28,425,086	41,027,731
Furnace flux (limestone)	4,566,923	8,448,314	4,788,866	8,791,840
Railroad ballast	603,870	938,465	483,395	733,264
Refractory	[2]	[2]	131,214	1,445,489
Agricultural	1,075,943	3,306,754	1,089,748	3,255,974
Other uses [3]	15,213,556	25,003,504	14,417,088	22,439,139
Total	47,931,758	76,881,926	49,335,397	77,693,437
Grand total	48,143,924	82,086,848	49,535,776	83,450,073

[1] Revised figure.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Includes refractory (1962), and riprap.

TABLE 12.—Stone sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Adams, Cumberland, York	6,105,873	$12,622,809	6,800,782	$13,721,004
Berks	3,200,677	4,823,352	3,192,310	4,083,477
Blair, Huntingdon	1,355,747	3,496,433	1,383,193	2,373,561
Bucks	1,671,151	3,055,563	2,859,489	5,117,736
Butler	1,185,839	2,325,491	1,082,807	2,087,679
Cambria	5,000	15,000	2,700	8,100
Carbon, Monroe, Schuylkill	897,183	2,207,521	708,597	1,854,051
Centre	2,027,577	4,124,154	2,068,603	3,770,312
Chester	2,559,595	4,246,967	2,133,717	3,888,616
Dauphin	1,102,812	1,770,328	1,026,014	1,499,608
Erie			140	225
Fayette, Somerset	1,495,280	2,866,745	1,529,179	2,937,153
Franklin	782,139	1,212,870	1,042,780	1,360,517
Juniata, Mifflin, Snyder	724,316	1,256,552	691,999	1,102,674
Lackawanna	[1]	[1]	136,986	272,114
Lancaster	3,121,121	4,687,386	3,094,198	4,380,148
Lawrence	2,519,025	4,030,229	2,601,792	4,348,166
Lebanon	1,358,550	2,362,526	1,436,793	2,444,595
Lehigh, Northampton	7,956,320	10,069,009	7,183,314	10,550,034
Luzerne	327,516	533,601	[1]	[1]
Montgomery	4,172,474	6,812,006	4,189,420	6,694,731
Northumberland	48,538	85,916	56,150	99,600
Potter	7,160	205,132	8,702	254,751
Wayne	[1]	[1]	117,607	185,807
Westmoreland	651,592	1,101,029	741,910	1,289,389
Undistributed [2]	4,868,439	8,176,229	5,446,594	9,126,025
Total	48,143,924	82,086,848	49,535,776	83,450,073

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes Allegheny, Armstrong, Bedford, Clarion, Clinton, Delaware, Fulton, Jefferson (1963), Lycoming, Mercer, Montour, Perry, Susquehanna, Tioga, Union, Washington, and Wyoming Counties, and counties indicated by footnote 1.

Sulfur.—Production of brimstone, recovered in the liquid purification of refinery gases in Delaware and Philadelphia Counties decreased in 1963. Hydrogen sulfide, recovered at a refinery in Philadelphia County, was used in manufacturing sulfuric acid. Processes used were the Claus, single stage catalytic oxidation of hydrogen sulfide, and the Girdler system. Sulfuric acid was recovered as a byproduct at zinc smelters and roasters.

Talc.—Production of sericite schist from three open-pit mines in Adams County decreased in 1963. The asphalt filler and insecticide markets were depressed, but the roofing market consumed five times more ground sericite schist than in 1962. Consumption for joint cement also increased in 1963.

Tripoli.—Sales of tripoli chiefly to the abrasives industry (buffing compound) were about one-fourth greater than in 1962. Production was reported from two quarries in Lycoming County.

Vermiculite (Exfoliated).—There was an excellent market for exfoliated vermiculite in the State in 1963 as sales increased significantly over 1962. Crude vermiculite from Montana, South Carolina, and a smaller quantity from Southern Rhodesia, was processed and sold for a variety of uses, chiefly for plaster aggregate, insulation, concrete aggregate, and insulation cement.

METALS

Beryllium.—The Beryllium Corp. with operations at Reading and Hazleton processed beryl to beryllium metal, alloys and compounds.

Cadmium.—Cadmium was recovered from flue dusts collected at the zinc smelters of St. Joseph Lead Co. at Josephtown and the New Jersey Zinc Co. at Palmerton.

Cobalt.—Production of cobalt, leached from the iron cinders of roasted pyrites, which had been recovered as a byproduct in iron ore mining, increased sharply in 1963.

Columbium.—A new columbium processing facility capable of processing almost any columbium ore or concentrate was put on stream in October by Kawecki Chemical Co. at Boyerstown.

Copper.—Copper concentrates were recovered as a byproduct of processing iron ore at an operation in Lebanon County. Output was significantly greater than in 1962.

Ferroalloys.—Shipments of ferroalloys increased over 50,000 tons to total 509,000 tons valued at $91.2 million. Ferromanganese shipments comprised 91 percent and spiegeleisen 8 percent of total shipments. Other shipments included ferromolybdenum, ferrotungsten, and ferrocolumbium.

Gold and Silver.—Sharply increased recovery of gold and silver was reported from the copper concentrates recovered in milling iron ore in Lebanon County.

Iron Ore.—Increased production of magnetite was reported from the Cornwall and Grace iron ore mines at Cornwall and Morgantown, respectively. Concentrates were prepared by magnetic separation at processing plants located at the mine sites. Most of the concentrates were processed into pellets by agglomeration at the processing plants. Shipments of pellets remained at a high rate.

Iron and Steel.—The upturn in the economy was reflected in the 10-percent increase in production of both pig iron and steel in Pennsylvania. The State continued to rank first in the Nation in iron and steel production. Output of pig iron was 17.3 million tons and according to the American Iron and Steel Institute, 25.2 million tons of steel was produced. Steel production was 84 percent from open-hearth furnaces; most of the balance was from electric furnaces, plus smaller quantities from Bessemer converters and from new oxygen-lance furnaces. Of the pig iron production, 89 percent was classed as basic. In order of production, other classes were Bessemer, malleable, foundry, and low phosphorous. A small tonnage was made directly into castings.

Receipts of U.S. produced iron ore decreased 9 percent, but foreign ore receipts increased slightly. To meet the increased demand, iron ore stocks were depleted to the extent of 1.7 million tons. At yearend stocks were 14 percent less than 1962. Of the total iron ore consumed, 55 percent was prepared by agglomeration and 45 percent was consumed directly in blast or steel furnaces. Fluxes consumed by the iron and steel industry included 3.2 million tons of limestone and 2.1 million tons of dolomite. Other materials consumed were 1.2 million tons of mill cinder and roll scale, 0.9 million tons of raw flue dust, 1.5 million tons of steel furnace slag, 11.9 million tons of coke and coke breeze, 240,000 tons of anthracite, 15.3 million tons of pig iron and hot metal, and 9.7 million tons of scrap.

Agglomerate consumption in iron and steel furnaces was 18.7 million tons of which two-thirds was U.S. sinter (regular), and one-fifth was pellets. The balance of the agglomerates consumed were semi- and-self-fluxing sinter and pellets, and foreign agglomerates. In the operation of the iron and steel furnaces, 5.9 million tons of slag was produced, 700,000 tons of flue dust was recovered, and 120,000 tons of scrap was produced.

Ten companies operated 21 plants in the State, a reduction of 1 company and plant from that of 1962. Sixty-four blast furnace stacks were active, a reduction of three from that of 1962.

The new basic oxygen steelmaking technique gained impetus in the State as both Allegheny Ludlum Steel Corp. and Pittsburgh Steel Co. announced construction plans to install oxygen furnaces. A new vacuum melting process, featuring hot metal charging into a 60,000-pound vacuum induction furnace, was being installed by Latrobe Steel Co.

Iron and Steel Scrap.—Increased markets for steel brought about consumption of larger quantities of iron and scrap by the steel industry. The larger metropolitan areas such as Pittsburgh, Philadelphia, and Harrisburg led in collection of scrap. The leading varieties shipped were No. 1 heavy melting steel, No. 2 and all other bundles, cast-iron scrap and other borings, and No. 1 and electric furnace bundles.

Slag (Iron-Blast-Furnace).—Although production of iron-blast-furnace slag decreased from 6.2 million tons in 1962 to 5.9 million tons in 1963, Pennsylvania continued to rank first in output of this processed commodity with 25 percent of the National production. Average value increased slightly to $1.80 per ton. As in past years, chief markets were aggregate use in highway and airport construc-

tion, bituminous construction, portland-cement construction, and for railroad ballast.

Smelters.—Two zinc smelters were active in 1963. The Palmerton plant of the New Jersey Zinc Co. processed concentrates from the company operations at Jefferson City, Tenn., Friedensville, Pa., Austinville, Va., Canon City, Colo., and crude ore from Sterling Hill, N.J. Other domestic and some foreign concentrates also were processed. Zinc metal was produced but no lead concentrates were processed in 1963, being shipped to outside smelters. A byproduct sulfuric acid plant, a cadmium recovery unit, and a new anhydrous ammonia plant were part of the Palmerton complex. The Josephtown plant of St. Joseph Lead Co. smelted zinc concentrates from its New York and Missouri operations, plus other domestic and foreign concentrates. Zinc oxide, zinc metal, cadmium, and sulfuric acid were produced at the Josephtown plant.

Zinc.—Sphalerite produced at the Friedensville mine of the New Jersey Zinc Co. was concentrated at the mine and shipped to the company smelter at Palmerton. Mine output increased substantially over that of 1962 to meet the increased demand for zinc metal in 1963.

REVIEW BY COUNTIES

Adams.—Total stone output was 10 percent more than that of 1962. Limestone, chiefly for use as flux in iron and steel plants, concrete aggregate, roadstone, and stone sand, was mined and crushed at a plant west of Hanover, by Bethlehem Limestone Co., a subsidiary of Bethlehem Steel Co., Teeter Stone, Inc., a subsidiary of Harry T. Campbell Sons Corp., Gettysburg, and Gettysburg Limestone Products, Inc., Fairfield, quarried and crushed limestone chiefly for concrete aggregate and roadstone. The Ruberoid Co., Roofing Granule Division, crushed and ground stone at its Graystone quarry (quartzite) and the Green Spoils Dump (basalt) east of Charmian. The stone was crushed and ground for use as roofing granules, tennis court surfacing, stone dust, and asphalt filler.

Mauna Mining Corp. produced sericite schist at an open-pit mine near Gardner. The crude material was trucked to a mill at Carlisle (Cumberland County) and ground for use as a filler in asphaltic compounds and roofing. Summit Industries, Inc., operated two open-pit mines near Mount Hope and Bendersville. The crude material was trucked to the company plant at Aspers to be crushed, screened, and ground, chiefly for use as asphalt filler and for joint cement.

Shale, chiefly for building brick, was mined by Alwine Brick Co., New Oxford, and Gettysburg Drain Tile Works, Gettysburg, at virtually the same rate as in 1962.

Allegheny.—Bituminous coal production decreased 8 percent. Of total production, 76 percent was mined at 20 underground mines, the balance at 18 strip and 2 auger mines. Almost 100 percent of the underground production was mechanically loaded by 25 mobile loaders, and 17 continuous miners. There was a decrease of 12 mobile loaders and 12 continuous miners from the number in 1962. Equipment at strip mines included 34 power shovels, 6 draglines and 15 bulldozers. Five cleaning plants cleaned 75 percent of total output. One of the larger cleaning plants used three thermal drying units.

TABLE 13.—Value of mineral production in Pennsylvania by counties[1 2]

County	1962	1963	Minerals produced in 1963 in order of value
Adams	(3)	(3)	Stone, sericite schist, clays.
Allegheny	(3)	$35,348,049	Coal, cement, clays, sand and gravel, stone, iron ore (pigment material).
Armstrong	(3)	(3)	Coal, sand and gravel, clays, stone, lime.
Beaver	$3,866,842	3,535,030	Coal, sand and gravel, clays.
Bedford	2,288,829	(3)	Stone, coal, lime, sand and gravel.
Berks	34,655,423	32,397,801	Iron ore, cement, stone, clays, cobalt, coal, pyrites, sand and gravel.
Blair	2,160,807	1,903,668	Stone, clays, coal, sand and gravel.
Bradford	(3)	(3)	Sand and gravel, coal.
Bucks	(3)	(3)	Stone, sand and gravel, clays.
Butler	16,034,719	14,486,841	Coal, cement, stone, lime, sand and gravel, clays.
Cambria	34,419,060	37,754,195	Coal, clays, sand and gravel, stone, iron ore (pigment material).
Cameron	(3)	264,698	Coal.
Carbon	(3)	6,774,955	Coal, stone, sand and gravel.
Centre	(3)	(3)	Lime, stone, coal, clays.
Chester	(3)	(3)	Stone, lime, clays, gem stones.
Clarion	13,627,949	13,844,560	Coal, stone, clays, sand and gravel.
Clearfield	27,139,085	28,418,087	Coal, clays, sand and gravel.
Clinton	1,812,797	1,871,537	Coal, stone, clays.
Columbia	(3)	3,269,045	Coal, sand and gravel, clays, peat.
Crawford	(3)	132,924	Sand and gravel.
Cumberland	(3)	(3)	Stone, sand and gravel, clays.
Dauphin	3,329,923	3,559,293	Stone, coal, clays, sand and gravel, lime.
Delaware	(3)	(3)	Stone.
Elk	1,783,675	(3)	Coal, sand and gravel.
Erie	(3)	(3)	Sand and gravel, peat, stone.
Fayette	(3)	(3)	Coal, stone, clays, sand and gravel.
Forest	(3)	(3)	Sand and gravel.
Franklin	(3)	(3)	Stone, sand and gravel.
Fulton	(3)	(3)	Stone, sand and gravel.
Greene	(3)	59,373,257	Coal.
Huntingdon	(3)	(3)	Sand and gravel, stone, coal, clays.
Indiana	(3)	(3)	Coal, clays.
Jefferson	(3)	(3)	Coal, clays, stone, sand and gravel.
Juniata	(3)	(3)	Stone, lime.
Lackawanna	(3)	10,272,932	Coal, stone, sand and gravel.
Lancaster	(3)	(3)	Stone, coal, sand and gravel, clays, lime.
Lawrence	(3)	(3)	Cement, stone, coal, clays, sand and gravel, peat.
Lebanon	(3)	(3)	Iron ore, copper, stone, lime, coal, cobalt, gold, pyrites, silver.
Lehigh	(3)	(3)	Cement, zinc, stone, gem stones.
Luzerne	(3)	(3)	Coal, stone, sand and gravel, peat, clays.
Lycoming	1,530,655	1,519,666	Stone, sand and gravel, coal, tripoli.
McKean	211,590	(3)	Clays, coal, sand and gravel.
Mercer	(3)	(3)	Coal, sand and gravel, stone.
Mifflin	1,989,202	1,979,023	Sand and gravel, stone, lime.
Monroe	1,049,520	562,571	Stone, sand and gravel, clays, gem stones.
Montgomery	13,655,719	13,097,487	Stone, cement, lime, clays, sand and gravel, gem stones.
Montour	(3)	(3)	Stone, sand and gravel.
Northampton	73,728,150	66,800,123	Cement, stone, sand and gravel.
Northumberland	12,941,584	(3)	Coal, clays, stone, lime.
Perry	(3)	(3)	Stone.
Philadelphia	(3)	(3)	Sand and gravel.
Potter	205,132	254,751	Stone.
Schuylkill	50,085,171	(3)	Coal, stone, sand and gravel, clays.
Snyder	430,511	424,159	Stone, sand and gravel, coal, clays, lime.
Somerset	10,657,312	13,333,376	Coal, clays, stone, sand and gravel.
Sullivan	63,122	66,717	Coal.
Susquehanna	(3)	(3)	Stone.
Tioga	(3)	(3)	Coal, stone.
Union	(3)	(3)	Stone.
Venango	(3)	(3)	Coal, sand and gravel.
Warren	226,253	318,767	Sand and gravel.
Washington	(3)	(3)	Coal, stone, clays.
Wayne	474,698	(3)	Stone, peat, coal, sand and gravel.
Westmoreland	20,072,149	(3)	Coal, stone, lime.
Wyoming	(3)	(3)	Sand and gravel, stone.
York	16,764,312	17,146,330	Cement, stone, lime, clays, sand and gravel, mica.
Undistributed	[4] 478,299,683	488,154,601	
Total	[4] 823,504,000	856,864,000	

[1] Pike County is not listed because no production was reported.
[2] Excludes value of production for LP gases, natural gasoline, petroleum, natural gas, and some gem stone unspecified by counties; included with "Undistributed."
[3] Included with "Undistributed" to avoid disclosing individual company confidential data.
[4] Revised figure.

Production of portland cement increased in 1963. Two plants were in operation, one operated by Universal Atlas Cement Division of United States Steel Corp., Universal; and one by Green Bay Cement Co., Neville Island. The former company operated a two-kiln dry process plant, the latter a three-kiln wet process plant. The latter company installed a new kiln, 500 feet in length, in 1963, sharply increasing its capacity. Portland slag and general use types were the leading cements produced. Output was consumed mostly in Western Pennsylvania. Ready-mixed concrete companies and cement-product manufacturers were the leading consumers.

Sand and gravel production increased 11 percent from that of 1962, mainly because of increased production of gravel for use as building aggregate. About 65 percent of the total output reached consumers as processed material. Output was reported by four producers with plants located at Harmarville, Natrona Heights, and Pittsburgh. Harry Zubik Co., Inc., recovered material from river deposits with a floating dredge.

Miscellaneous clay production, which was entirely for building brick manufacture, increased 15 percent in 1963. Five producers were active, the larger of which were Milliken Brick Co., Inc., Wilkinsburg, and Suburban Supply Co., Murraysville.

Dimension sandstone for rubble and rough construction was produced at Elizabeth and Finleyville.

Pennsalt Chemicals Corp. produced red iron oxide pigments from the red mud residue from a former aluminum reduction plant at Natrona. Perlite, shipped from mines in Colorado, was expanded by Panacalite Perlite Co., Pittsburgh, and Perlite Manufacturing Co., Carnegie. The material was used mainly for loose fill insulation, building plaster, and concrete aggregate.

Armstrong.—Bituminous coal production increased 18 percent. Of total output, 61 percent was mined at 44 underground mines, 36 percent at 45 strip mines, and 3 percent at 13 auger mines. Of the underground production 94 percent was mechanically loaded by 30 mobile loaders, 4 continuous miners, and 20 face conveyors. Eight cleaning plants cleaned 48 percent of total output. One plant had thermal drying equipment. Equipment at strip mines included 76 power shovels, 22 draglines, 62 bulldozers, and 7 carryall scrapers.

Tonnage and value of sand and gravel production increased 17 and 24 percent, respectively. The county ranked second in production and third in value in the State. Increased demand for construction sand and gravel was the principal reason for the increased output. Davison Sand & Gravel Co., the principal producer, recovered material from the Allegheny River near Clinton using a marine dredge. When necessary, additional processing was done at the company's New Kensington plant. Glacial Sand & Gravel Co. (Tarrtown) and Manorville Sand Co. (Manorville) processed sand and gravel. John Cihat and Universal Sand and Loam Co. produced sand from pits near Leechburg for industrial and construction use, respectively.

Production of clay remained at virtually the same rate as in 1962. Output was chiefly fire clay for manufacturing firebrick and block, vitrified sewer pipe, and other heavy clay products. Eight producers were active with output centered in the Kittanning area. The lead-

ing producer was the Freeport Brick Co., Freeport. The plant of Continental Clay Products Co. at Kittanning was idled by a strike from June 19 to December 18, 1963. Kittanning Brick Co. reported the installation of a mechanical loading machine at its underground mine at Adrian.

Mowrey & Good (a new producer) produced and crushed limestone for agstone at quarries near Girty and McWilliams. Beaver Run Limestone Co., Apollo, produced crushed limestone for concrete aggregate and roadstone. C. D. McCanna, Kittanning, produced crushed limestone for use in making hydrated aglime. Robert E. Toy, Kittanning, discontinued his limestone and lime operations during the year.

Beaver.—Coal production decreased 29 percent from that of 1962. Of total production, 77 percent was mined at 13 strip mines, the balance at 1 underground and 5 auger mines. Equipment at strip mines included 18 power shovels, 11 draglines, and 20 bulldozers.

Increased demand for sand and gravel for building and paving aggregate was reported by four producers. Iron City Sand & Gravel Corp., Division of McDonough Co., operated a dredge on the Ohio River. Shippingport Sand & Gravel Co. produced sand and gravel at Shippingport and Georgetown. Darlington Ready Mix Co. recovered sand and gravel from a pit at Darlington. Ellwood Stone Co. processed sand for industrial use from a pit near Ellwood City.

Fire clay production remained stable but miscellaneous clay output increased sharply. Production was centered in the north-central part of the county near New Brighton and Darlington. Output was mostly fire clay for building brick manufacture. Some clay also was used in firebrick and vitrified sewer pipe manufacture. The leading producers were Standard Clay Manufacturing Co., New Brighton; Colonial Clay Products Co., Fallston; and Eastvale Clay Products Co., Beaver Falls. Colonial Clay Products Co. reported completion of a modernization program. Darlington Brick Division, General Dynamics Corp., purchased Central Commercial Company's roofing granule plant at Darlington at midyear. Both companies produced artificially colored granules in 1963.

Bedford.—Increased production of sandstone raised total stone output 67 percent over that of 1962. Leap Ganister Rock Co., Hyndman, crushed ganister rock from stockpile for use as furnace or converter linings. Detwilers Industries, Inc., Weyant, quarried and crushed sandstone for concrete aggregate and roadstone. Output was from the Chemung sandstone conglomerate, which contains about 50 percent sand and meets a need for sand in the county and surrounding area. Limestone was quarried near Everett and New Paris for use as concrete aggregate, roadstone, dust for coal mines, and for lime manufacture.

Bituminous coal production decreased by 10 percent. Three less underground mines (11) were active but one additional strip mine (3) was put into operation. Most of the underground production was mechanically loaded by a continuous mining machine. Equipment at strip mines included four power shovels, two draglines, and three bulldozers.

Feight Bros. recovered sand from a pit near Everett for use as building material. New Enterprise Stone & Lime Co. produced hydrated aglime at its Ashcom plant. J. Mason Kerr's lime plant was permanently abandoned.

Berks.—Bethlehem Cornwall Corp. mined crude magnetite, containing recoverable pyrite, copper, gold and silver, and cobalt at Morgantown. A concentrator at the mine processed the ore by crushing and grinding, magnetic separation, and flotation to produce iron ore pellets and pyrite and copper concentrates.

Reduced production of portland and masonry cement was reported by Allentown Portland Cement Co. at its Allentown plant. The company mined the limestone and cement rock used in the manufacturing process. Output which was entirely general use and moderate heat and high-early-strength types, both air-entrained and non-air-entrained, was shipped mainly in bulk by truck and railroad to consumers in Eastern Pennsylvania, New Jersey, New York, and Connecticut. Ready-mixed concrete companies were the leading consumers.

Production of stone decreased 15 percent in 1963. Four companies quarried and crushed limestone at six operations. The stone was chiefly for concrete aggregate, roadstone, and for the manufacture of cement. In addition to output by Allentown Portland Cement Co., Eastern Lime Corp. operated quarries at Oley and Kutztown, Berks Products Corp. quarried at Temple and E. J. Breneman, Inc., produced near Sinking Spring. Reading Poultry Food Co., Reading, crushed oystershell for use as poultry grit and mineral food. Martin Quarries quarried crushed sandstone near Bechtelsville for use as aggregate. Crushed basalt production decreased 17 percent in 1963 as the aggregate and railroad ballast markets were depressed. Producers were The John T. Dyer Quarry Co., Birdsboro, Bradford Hills Quarry, Inc. (processing waste rock from the Grace iron ore mine at Morgantown), and Pottstown Trap-Rock Quarries, Inc., Douglassville. The latter company installed a new crusher and screening plant in 1963.

Increased output of miscellaneous clay for building brick was reported by Glen-Gery Shale Brick Corp. from pits near Wyomissing and Shoemakersville.

Anthracite was mined at a rate slightly less than that of 1962.

Sand and gravel production decreased significantly. Refractory Sand Co., Inc., the leading producer, recovered fire and furnace sand at its Grings Quarry, Sinking Spring, and Schildt Bros., Temple, also produced sand and gravel mostly for building and paving aggregate.

Blair.—Crushed limestone was produced by eight companies operating nine quarries near Hollidaysburg (3), Claysburg, Altoona, Royer, Tyrone, Duncansville, and Roaring Spring. Output was sold or used chiefly for roadstone with smaller quantities for agstone and asphalt filler. The leading producer was New Enterprise Stone & Lime Co. General Refractories Co. (Hollidaysburg) and J. L. Hartman (Sproul) produced crushed sandstone for ganister. C. E. Powell took over operation from Basalt Traprock Co. and produced crushed sandstone chiefly for aggregate but also for riprap and railroad ballast.

Near Williamsburg, Harbison-Walker Refractories Co. mined fire clay and Grannas Brothers mined kaolin for use in firebrick manufacture.

Only a small production of bituminous coal was reported in 1963. There was a sharp reduction in strip-mined tonnage.

Output from two sand and gravel deposits near Hollidaysburg remained virtually the same as in 1962. All of the sand was processed and used primarily as building aggregate.

West Virginia Pulp & Paper Co. regenerated lime at its pulp and paper plants in Tyrone and Williamsburg for reuse in its manufacturing process.

Bradford.—Output of sand and gravel increased from that of 1962. Towanda Sand & Gravel Co., Inc., and J. A. Eck & Sons, Inc., supplied the State highway department with large quantities of road base and antiskid material. Additional quantities of sand and gravel were processed for use as building aggregate and fill.

Bituminous coal was produced at one strip operation.

Bucks.—Five quarries near Rushland, Eureka, Trevose, New Hope, and Buckingham produced limestone solely for use as concrete aggregate and roadstone. The leading limestone producers were Eureka Stone Quarry, Inc., Eureka, and New Hope Crushed Stone & Lime Co., New Hope. Some dimesion limestone for use as rough construction stone was quarried near Trevose. Dimension sandstone for rough construction was quarried by Delaware Quarries at Lumberville. Crushed sandstone was produced by George Wiley at Point Pleasant for concrete aggregate and roadstone. Samuel M. Yoder Estate quarry was sold in 1963 and did not operate. Crushed granite for concrete aggregate and roadstone was produced by Vernon Horn near Chalfont. The company reported the installation of a new primary crusher in 1963. Crushed basalt production for use as aggregate increased over half that of 1962. Five producers were in operation, the larger of which were General Crushed Stone Co., Quakertown, and Tohickon Stone Quarry, Weisel. Two producers quarried dimension basalt; sales were mostly for dressed monumental uses. Tohickon Stone Quarry added an additional secondary crusher and expanded the screening and storage area.

Despite a production decline of 23 percent, the county remained the leading area for sand and gravel production. The Warner Co.'s Van Sciver plant, the leading producer, was also the largest sand and gravel producer in the State. Output was reported by six other companies, the larger of which were Durnan and Good, and Frank Casilio & Sons, Inc., both at Upper Black Eddy, Penn Valley Crushed Stone Co., Levittown, and Silvi Concrete Products, Tullytown.

Miscellaneous clay was mined by Quakertown Brick & Tile Co. near Quaktertown for building brick manufacture.

Vermiculite imported from Southern Rhodesia was processed by Hyser & Lewellen at Southampton. The material was for use primarily as insulation in residential projects and as concrete aggregate.

Butler.—Coal production decreased 15 percent from that of 1962 and the number of active mines decreased by 6 to 58. Of total production 84 percent was mined at 30 strip mines, 8 percent each at 19 underground and 9 auger mines. Of the underground production two-

thirds was mechanically loaded chiefly by mobile loading machines. Four cleaning plants were active preparing 23 percent of total output. Equipment at strip mines included 44 power shovels, 29 draglines, and 48 bulldozers.

Penn-Dixie Cement Corp. produced both portland and masonry cement at its two-kiln wet process plant at West Winfield. Shipments were mostly general use and moderate heat types of portland cement by truck in bulk to ready mixed concrete companies in western Pennsylvania.

Limestone production decreased slightly. Five companies operated quarries, the leading of which were Penn Dixie Cement Co., West Winfield; Sechan Limestone Co., Prospect; and Alleghany Mineral Corp., Harrisville. The crushed limestone was used for concrete aggregate, roadstone, cement manufacture, flux in iron and steel plants, and agstone. Grove City Limestone Co., Branchton, enlarged its crushing facilities.

Output of sand and gravel increased 10 percent, chiefly because of increased demand for building sand and gravel. Principal producers were Highway Sand & Gravel Co., Inc., and H. W. Cooper, both of Slippery Rock. Penn-Dixie Cement Corp. produced sand and limestone for its use in the manufacture of cement. Mercer Lime & Stone Co. produced both quicklime and hydrated lime at Branchton for aglime and for consumption in steel furnaces.

Scott Borland Brick Yard mined miscellaneous clay at Mars and produced building brick.

Cambria.—Coal production increased 18 percent and the number of active mines increased by 8 to 121. Of total production, 88 percent was mined at 101 underground mines and 12 percent at 18 strip and 2 auger mines. Almost 97 percent of the underground production was mechanically loaded by 18 mobile loaders, 86 continuous miners, and 30 face conveyors. The county led in number of operating continuous mining machines. Equipment at strip mines included 39 power shovels, 13 draglines, and 27 bulldozers. Nine cleaning plants prepared 76 percent of total output.

A slight increase was recorded in clay production. Miscellaneous clay production was entirely for building brick manufacture and fire clay output was mostly for manufacturing vitrified sewer pipe. The leading producer was the Triangle Clay Products Co., Johnstown.

Parry Sand & Gravel Co., Johnstown, produced sand and gravel for construction. Crushed sandstone for silica brick and for aggregate was produced by Samuel Nicosia near Johnstown. Lanzendorfer Minerals Co. produced sulfur mud for iron oxide pigments at its No. 31 mine near Nanty Glo.

Cameron.—Coal production from one strip operation was cleaned at a heavy media preparation plant.

Carbon.—Anthracite production decreased 4 percent to 645,000 tons even though the number of men employed rose by 37 to 343. The leading anthracite producers were Lehigh Valley Anthracite, Inc., and Greenwood Stripping Corp.

Refractory sandstone (ganister) was produced by North American Refractories at Palmerton. Fauzio Bros. produced crushed sandstone aggregate near Nesquehoning. Alliance Sand Co. (Palmerton),

the principal producer, processed sand for building and paving and for use in manufacturing cement.

Centre.—The county was the leading lime producing area. Quicklime and hydrated lime was produced by three companies at a greater rate than in 1962 for sale chiefly to the steel and paper industries. They were National Gypsum Co. and The Warner Co., both at Bellefonte, and Standard Lime & Cement Co. at Pleasant Gap. These companies were also the leading producers of limestone. Most of the lime output was consumed within the State, but significant quantities were shipped to Maryland, New York, and Ohio.

Limestone production increased slightly over that of 1962. The principal uses of the limestone were for lime manufacture, concrete aggregate, roadstone, glassmaking, flux in iron and steel plants, and agstone. Six companies produced crushed and broken limestone from quarries near Bellefonte (2), Pleasant Gap (2), State College, and Marion Township. In addition to the lime-producing companies, Fry Coal & Stone Co. and Neidigh Brothers Limestone Co., Inc., quarried significant quantities of limestone. Warner Co. made improvements at its Bellefonte operation by installing new shovels in the quarry and renovating its processing plant.

Coal production increased 4 percent. Of total production, 94 percent was mined at 13 strip mines, 5 percent at 11 underground mines, the balance at 1 auger mine. Of the underground production 44 percent was hand-loaded onto face conveyors. Two cleaning plants, one of which had thermal drying equipment, cleaned 59 percent of total production. Equipment at strip mines included 32 power shovels, 14 draglines, and 20 bulldozers.

Fire clay was mined by Harbison-Walker Refractories Co. at its Blair mine near Stormstown for firebrick manufacture.

Chester.—Quantity and value of stone output decreased 17 and 8 percent, respectively, but output continued to exceed 2 million tons. The Warner Co. produced limestone at its Johnson quarry and Paoli plant for use as concrete aggregate and roadstone. The company's Cedar Hollow plant at Devault produced crushed limestone chiefly for blast-furnace and open-hearth flux, lime manufacture, and dolomite for magnesium plants. Fry Coal & Stone Co., Division of Martin-Marietta Corp., purchased the Valley Forge Stone Co. plant near Malvern and quarried limestone for concrete aggregate, roadstone, and riprap. Bradford Hills Quarry, Inc., Downingtown, produced limestone for concrete aggregate and roadstone. Four producers quarried dimension sandstone chiefly for rough construction. The leading were Frank Rarick at Malvern and Abram T. Minor at Avondale. A significant decrease in production of crushed basalt was recorded reflecting a lull in roadbuilding activity in 1963. V. Di Francesco & Sons, Devault, and Keystone Trappe Rock Co., Glenmoore, produced crushed basalt, and French Creek Granite Co., Inc., quarried dimension basalt near St. Peters chiefly for dressed architectural uses.

Quicklime and hydrated lime was produced by The Warner Co. near Devault for sale as Mason's lime, aglime, and lime for sewage treatment and acid neutralization to consumers chiefly in Pennsylvania and New Jersey.

McAvoy Vitrified Brick Co. mined miscellaneous clay at Phoenixville for use in manufacturing building brick. Mineral specimens including wolframite, zoisite and pyrrhotite in quartz, and limonite cube crystals were collected near Cornog, Phoenixville, and Williams Corners.

Clarion.—Coal production increased 6 percent, but the number of active mines decreased by 8 to 40. Of total production, 96 percent was mined at 32 strip mines, 3 percent at 5 underground mines, and 1 percent at 3 auger mines. The county was second ranked in strip tonnage. Most of the underground production was mechanically loaded by one mobile loader and two continuous miners. Equipment at strip mines included 84 power shovels, 46 draglines, and 63 bulldozers. Six cleaning plants were active preparing 59 percent of total output. One plant had thermal drying equipment.

Limestone for use as concrete, roadstone, and agstone, was produced by Allegheny Mineral Corp. at a quarry and plant east of Parker. Emlenton Limestone Co., Inc., produced limestone near Turkey City for roadstone.

Total clay production was slightly less than in 1962. Output was mostly fireclay for use in manufacturing refractories and building brick. Leading producers were Climax Division of A. P. Green Fire Brick Co., Climax, and New Bethlehem Tile Co., New Bethlehem.

Sand and gravel output declined more than 20 percent from that of 1962, owing mainly to less demand for paving sand. Glacial Sand & Gravel Co. processed virtually all of the material at its Parker No. 2 plant.

Clearfield.—The county continued as the leading clay producing area in the State in terms of both tonnage and value. Twenty-four mines produced 465,219 tons of clay, valued at $3.3 million. Most of the output was fire clay, mined by or for the major refractory producing companies. Harbison-Walker Refractories Co. with eight operations was the leading producer. Augenbaugh Coal Co., Inc., stripped a significant quantity of fire clay for sale to firebrick manufacturers. Output was chiefly from the areas surrounding Curwensville, Bigler, Grampian, West Decatur, and Osceola Mills.

Coal production increased 4 percent, but the number of active mines decreased by 17 to 170. Of total production, 85 percent was mined at 96 strip mines, 13 percent at 66 underground mines, and 2 percent at 8 auger mines. The county led in strip production. Of the underground output, 69 percent was mechanically loaded by 4 mobile loaders, 4 continuous miners, and 34 face conveyors. There was a decrease of 11 mobile loaders and an increase of 1 continuous miner compared with 1962. Equipment at strip mines included 191 power shovels, 99 draglines, 161 bulldozers, and 2 carryall scrapers. Nine cleaning plants prepared 28 percent of the total output. Three of these plants had thermal drying equipment.

Clinton.—Coal production from four strip and two underground mines increased 18 percent. Almost all the coal was strip mined. Equipment included 11 power shovels, 4 draglines, and 10 bulldozers. One heavy media cleaning plant was in operation.

Lycoming Silica Sand Co., Salona, crushed and sized limestone for use as concrete aggregate and roadstone.

Miscellaneous clay was mined by Mill Hall Clay Products, Inc., at Castanea for manufacturing heavy clay products. F. E. Fink & R. H. Stackhouse mined fire clay near Lock Haven for firebrick manufacture. This company reported the depletion of its clay deposit in 1963.

Columbia.—Anthracite production increased 6 percent, to 411,000 tons, but the number of men employed decreased by 82 to 307. Jeddo-Highland Coal Co. was the leading producer.

Output of sand and gravel was slightly lower than the previous year due to lower demand for building sand and gravel. Bloomsburg Sand & Gravel Co. produced processed sand and gravel near Bloomsburg.

The Alliance Clay Product Co. mined miscellaneous clay at Mifflinville for use in manufacturing building brick. Moss and humus peat was recovered from bogs near Benton by Benton Peat Products, Inc.

Crawford.—Sand and gravel production increased for the third consecutive year, but was significantly less than the 142,000 short tons produced in 1959. The sand and gravel was produced by W. L. Dunn, Cochranton; Conneaut Lake Sand & Gravel, Conneaut Lake; and Hasbrouck Sand & Gravel, Titusville. About one-fourth of the output was unprocessed fill.

Cumberland.—Five companies operated limestone quarries producing chiefly crushed limestone for use as road material. Valley Quarries, Inc., Shippensburg; Bonny Brook Quarries, Carlisle; and Hempt Brothers, Inc., Camp Hill, were the leading producers.

Sand and gravel, chiefly for building and paving aggregate, was produced by Hempt Brothers, Inc., Camp Hill; R. A. Bender & Son, Mt. Holly Springs; and C&L Goodhart, Walnut Bottom.

Almost the entire county clay output was kaolin mined by Philadelphia Clay Co. near Mount Holly Springs for use in white cement manufacture.

Dauphin.—Tonnage and value of stone decreased 7 and 15 percent, respectively, as compared with that of 1962. Crushed limestone was quarried by H. E. Millard Lime & Stone Co., Palmyra; Bethlehem Limestone Co., Steelton; and George E. Ebersole & Sons, Hummelstown. Chief uses for the stone were for blast-furnace and open-hearth flux, concrete aggregate, and roadstone. Crushed basalt was quarried near Elizabethville by Faylor Lime & Stone Co. for aggregate and roadstone.

Anthracite production increased 76 percent but the number of men employed dropped by 5 to 181. Gangloff Bros. was the leading producer.

Production of miscellaneous clay for building brick by the Glen-Gery Shale Brick Corp. from pits near Harrisburg and Middletown was at a slightly higher rate than in 1962. Pennsy Supply, Inc., produced chiefly building sand and gravel at its Amity Hill plant at Duncannon. H. E. Millard Lime & Stone Co. produced hydrated aglime at Swatara.

Delaware.—Dimension sandstone was quarried at Media by Media Quarry Co. for use as rough construction stone and rubble. Dimension granite for rough construction was quarried near Lima and Swarthmore. Crushed basalt for the aggregate market was quarried by General Crushed Stone Co., Glen Mills, and V. DiFrancesco & Son, Havertown. Although production decreased slightly from that of

1962, the county continued to rank first in basalt production. General Crushed Stone Co. reported rennovating its processing plant in 1963.

Sinclair Refining Co. produced liquid sulfur as a byproduct in the liquid purification of oil refinery gas using a Claus-type process at its Marcus Hook refinery. Sun Oil Co., Marcus Hook, produced sulfur as a byproduct in single stage catalytic oxidation of hydrogen sulfide.

Perlite Products Co. expanded perlite at its Primos plant from crude material shipped from Colorado. The expanded material was used chiefly as building plaster aggregate, insulating material, concrete aggregate, and a soil conditioner.

Elk.—Coal production increased 47 percent chiefly due to increased strip and auger mining. One additional strip mine (9) and four new auger mines (5) were active, but one less underground mine (15) was in operation. Strip tonnage comprised 68 percent of output, underground 19 percent, and auger 13 percent. Mechanical loading at the underground mines consisted of handloading onto face conveyors. Equipment at strip mines included 20 power shovels, 4 draglines, 18 bulldozers, and 1 carryall scraper. One heavy media cleaning plant was in operation.

Gravel was produced by Stone Haven Mix from a portable plant near Johnsonburg for paving aggregate. No production of fire clay was reported in 1963.

Erie.—The county was third ranked in sand and gravel production in the State. Erie Sand Steamship Co. continued as the leading producer recovering sand by dredging. Six smaller operations were active producing mostly building and paving aggregate.

Corry Peat Products Co. recovered reed-sedge and humus peat from bogs near Corry and sold the material packaged and in bulk.

Sandstone riprap was quarried near Franklin Corners.

Fayette.—Coal production increased 16 percent even though the number of active operations decreased by 4 to 52. Auger production was reported in 1963; there was none in 1962. Over two-thirds of total production was mined underground. Two additional continuous mining machines (11) were put into operation. Ninety percent of underground production was loaded mechanically. Active at the 21 strip mines were 26 power shovels, 12 draglines, 19 bulldozers, and 3 carryall scrapers. Four cleaning plants prepared over two-thirds of total output.

Fry Coal & Stone Co., Division of Martin-Marietta Corp., produced crushed, ground, and sized limestone from the Lake Lynn quarry, Lake Lynn, and the Cool Spring quarry, Uniontown. The stone was sold for use as concrete aggregate, roadstone, dust for coal mines, and agstone. Increased production of crushed sandstone was reported. Connellsville Blue Stone Co. produced aggregate material at Scottdale and General Refractories produced ganister for silica brick. A small quantity of sandstone rubble was produced near Connellsville.

Clay production increased by almost half in 1963, due chiefly to increased fire clay production for firebrick and block manufacture. Fire clay output was reported by Kaiser Refractories and Chemicals Division, Kaiser Aluminum & Chemical Corp., and Harbison-Walker Refractories Co. both at Ohiopyle. Robert N. Mathews mined fire clay at Uniontown for sale to refractory manufacturers.

Reduced production of sand and gravel was reported by McClain Sand Co., Inc., at its dredge located near Point Marion.

Forest.—Tionesta Sand & Gravel, Inc., produced sand and gravel for building and paving at a stationary plant near Tionesta.

Franklin.—Chiefly due to increased roadbuilding in the area, production of stone increased 33 percent. Four producers quarried limestone, the larger of which were Valley Quarries, Inc., Chambersburg and Fry Coal & Stone Co. at Williamson and Zullinger. The limestone was used mainly for concrete aggregate and roadstone. Smaller quantities were sold for agstone and railroad ballast.

Building sand was produced at a stationary plant by Mt. Cydonia Sand Co., Inc., and by Caledonia Sand Co., both at Fayetteville.

Fulton.—H. B. Mellot Estate, Inc., produced limestone at the Morton quarry, Big Cove Tannery, and the Charlton quarry, Warfordsburg. The stone was crushed at local plants chiefly for use as concrete aggregate and roadstone; some was used for agstone.

Building and paving sand was produced at a stationary plant near Warfordsburg by H. B. Mellot Estate, Inc.

Greene.—The county was second ranked in coal production with output of 9.6 million tons, an increase of 5 percent over 1962. Almost all of the production was from 25 underground mines, but 5 small strip pits were in operation. There was a decrease of 3 to 82 in number of continuous miners, and the number of mobile loading machines in use dropped from 29 to 7 in 1963, but in addition, 18 were used behind continuous miners. Almost all the underground tonnage was loaded mechanically. Five cleaning plants prepared over half of the total output mostly by wet washing other than jigs. One plant had thermal drying equipment.

No clay mining operations were active in 1963.

Huntingdon.—The county continued as the leading industrial sand-producing area in the State. High values of this production ranked the county second in value of sand and gravel production while being fourth in tonnage. Industrial sand was produced by Pennsylvania Glass Sand Corp. at its Keystone Works near Mapleton Depot chiefly for sale to the glass industry. Other markets included pottery, foundry, molding, and engine sand uses.

New Enterprise Stone & Lime Co., McConnellstown, and Warner Co., Union Furnace, quarried and crushed limestone for use as concrete aggregate and roadstone. The latter company installed a hammermill with conveyor and screens in a plant improvement project. The Orbisonia quarry of New Enterprise Stone & Lime Co. was idle during the year. L. H. Parsons Stone & Lime Co. (a new producer), Orbisonia, quarried limestone for concrete aggregate, roadstone, and agstone. The closing of Harbison-Walker Refractories Co.'s quarry at Mt. Union, a major sandstone producer in 1962, resulted in sharply decreased county sandstone production. North American Refractories Co. continued its operation at Three Springs producing ganister for silica brick.

A small production of strip (three mines) and underground (four mines) coal was reported. Output was significantly higher than in 1962. Alexandria Fire Clay Co. mined fire clay near Alexandria for sale to mortar manufacturers.

Indiana.—Coal production increased 16 percent as number of active mines rose by 7 to 102. Most of the increased production was in underground-mined tonnage (68 mines) which comprised 86 percent of total output. Four additional continuous mining machines were in use (40) but 2 less mobile loaders (27) were in operation in 1963 at the underground mines. Of total underground output 97 percent was mechanically loaded. At the 33 strip mines, 45 power shovels, 16 draglines, and 47 bulldozers were in use. Nine cleaning plants prepared 76 percent of total production, 27 percent was crushed, and 7 percent was treated for dust allaying and antifreezing purposes. Three cleaning plants used thermal drying equipment.

L. H. Foehrenbach mined fire clay near Clymer for sale to refractory manufacturers.

Jefferson.—Coal production increased 30 percent as nine new mines were opened in 1963. Most of the increased output was attributed to more activity in strip, underground, and auger mining. Of total output, 69 percent was mined at 27 strip pits, 28 percent at 28 underground mines, and 3 percent at 10 auger mines. At underground mines, four additional continuous miners (six) were in operation. In addition, a significant tonnage was hand loaded onto conveyors and two duckbills were in use. Of underground output 86 percent was loaded mechanically. In use at strip mines were 49 power shovels, 16 draglines, 47 bulldozers, and 1 carryall scraper; at the auger mines 13 augering machines were used. Seven coal preparation plants were active, cleaning 45 percent of total production mostly by pneumatic methods. In addition, 61 percent was crushed, and 5 percent was treated.

Production of fire clay increased 73 percent due chiefly to increased consumption in building brick manufacture. In addition, firebrick and block and vitrified sewer pipe were produced. The leading of three producers was the Hanley Co., Summerville, and The Brockway Clay Co. with two operations at Brockway.

Sugar Hill Limestone Co. (a new operator), Brockway, quarried limestone for use as riprap and agstone. Brockway Sand & Gravel produced bank-run gravel near Brockway for paving.

Juniata.—Juniata Limestone Co. produced crushed limestone near McAlisterville, chiefly for use as road material; smaller quantities were sold for cement manufacture, fill, and agstone. Fulkroad Lime Quarry, McAlisterville, produced limestone to manufacture agricultural quicklime. Kaiser Aluminum & Chemical Corp. closed its quartzite quarry near Thompsontown.

Lackawanna.—Anthracite production decreased by 13 percent and the number of men employed dropped from 1,312 in 1962 to 1,086 in 1963. Moffat Coal Co., Inc., and Carbondale Coal Co., Inc., were the leading producers.

Stabler Construction Co. produced crushed sandstone from its West Mountain quarry near Scranton for use as concrete aggregate. New roadbuilding in the area sparked production.

Sand and gravel production increased 25 percent chiefly because of increased markets for building sand and gravel. Producers were Contractors Sand & Gravel, Inc., Madisonville; Scranton Sand & Stone Co., Gouldsboro; and The East Lemon Sand & Gravel Co., Dunmore.

Lancaster.—Production of crushed and broken limestone decreased slightly compared with that of 1962, but the county ranked second in limestone production. Sixteen companies operated 18 quarries mostly near Blue Ball, Talmage, Gap, Silver Springs, and East Petersburg. Leading producers were D. M. Stoltzfus & Son, Inc., Ivan M. Martin, Inc., Binkley & Ober, Inc., and Compass Quarries, Inc. Most of the crushed stone was for use as concrete aggregate and roadstone. Smaller quantities were used for agstone, stone sand, asphalt filler, and lime manufacture.

Anthracite production decreased slightly below that of 1962. Output was from dredging operations on the Susquehanna River.

Sand and gravel production at four operations was at virtually the same rate as that of 1962. Output was mostly sand for building and paving. Some fire or furnace sand also was produced. Milton Grove Sand, Inc., Milton Grove, was the leading producer.

Increased production of clay was recorded as the Glen-Gery Shale Brick Corp., Ephrata, and Lancaster Brick Co., Lancaster, consumed larger quantities of miscellaneous clay in building brick manufacture. Narvon Mines Limited, Narvon, sold fire clay for a variety of specialty uses. The latter company reported renovating its processing plant. Amos K. Stoltzfus produced agricultural quicklime at Elverson.

Lawrence.—Increased shipments of portland cement were reported, but masonry cement sales were less than in 1962. Two cement plants were active, one a four-kiln wet process plant operated by Bessemer Cement Co., Division of Diamond Alkali Co. at Bessemer, the other a two-kiln dry process plant operated by Medusa Portland Cement Co. at Wampum. Production was mostly the general use types and was shipped mainly by truck in bulk to ready-mixed-concrete companies, highway contractors, and concrete-product manufacturers. Shipments were almost evenly divided between Ohio and western Pennsylvania. Bessemer Cement Co. reported the installation of new equipment and improvement of its stone crushing and conveying departments.

Five companies produced crushed limestone and cement rock, mainly for cement manufacture, blast-furnace flux, concrete aggregate, and roadstone. Smaller quantities were used for dust in coal mines, agstone, and roofing paper filler. Bessemer Cement Co., Division of Diamond Alkali, near Bessemer, completed its modernization program in the crushing and screening departments which had started in 1962.

Coal production increased 38 percent because of increased output of the county's 21 strip mines. Only one small underground mine was active. One auger mine, two less than the number in 1962, produced only about half of the 1962 auger output. In use at the strip mines were 29 power shovels, 20 draglines, 27 bulldozers, and 1 carryall scraper. There were no active mechanical cleaning plants in 1963, but 17 percent of county output was crushed.

Clay production reported by eight producers increased 15 percent over 1962. Almost equal quantities of fire clay and miscellaneous clay were produced. Leading markets were the cement and steel industries. In addition, large quantities of building brick were produced. The leading producers were Ralph A. Veon, Inc., Enon Val-

ley, and Bessemer Cement Co., Division of Diamond Alkali Co. at Bessemer. Ralph A. Veon, Inc. installed a new dragline at its pit.

Three operators produced sand and gravel mostly for building and paving. The leading producer was Mahoning Valley Sand Co., West Pittsburg. Reed-sedge and humus peat, sold in bulk, was produced by D. M. Boyd near New Wilmington. Humus peat was recovered from a bog in Washington Township by Moore's Humus & Nursery. Zonolite Co. exfoliated crude vermiculite shipped from Montana and South Carolina at its Ellwood City plant.

Lebanon.—Crude magnetite, containing valuable byproducts such as copper, gold and silver, pyrites, and cobalt, was mined by Bethlehem Cornwall Corp. at Cornwall. The crude ore was processed in the Cornwall concentrator by crushing and grinding, magnetic separation, flotation, and agglomeration to recover all valuable byproducts.

Five producers operated limestone quarries near Lebanon (2), Annville (2), and Cornwall. The leading producers were H. E. Millard Lime & Stone Co. and Calcite Quarry Corp. The crushed limestone was for use primarily for road material, cement and lime manufacture, and metallurgical flux. Small quantities were for agstone and railroad ballast. Dimension limestone for rough construction was quarried near Myerstown. Calcite Quarry Corp., near Lebanon, installed additional crushing equipment and replaced the washing equipment at its limestone processing plant.

Quicklime and hydrated lime was produced at Annville by H. E. Millard Lime & Stone Co. chiefly for sale to the steel industry, for water purification, and for Mason's lime.

Anthracite production more than tripled over that of 1962 to 44,000 tons due to the large output of Talbot Realty Co., Inc., the leading producer.

Lehigh.—Sphalerite was mined by New Jersey Zinc Co. at Friedensville. The crude production was concentrated by flotation at the mine and shipped to Palmerton for recovery of the zinc metal.

The county continued to rank second in shipments of both portland and masonry cements. Portland cement shipments decreased slightly but sales of masonry cement were greater than those in 1962. Average prices for portland cement fell from $3.20 to $2.89 per barrel reflecting the current tight marketing structure along the Eastern seaboard. Four cement companies were in operation. They were The Whitehall Cement Manufacturing Co. (7-kiln dry process plant at Cementon), Lehigh Portland Cement Co. (10-kiln dry process plant at Fogelsville), Giant Portland Cement Co. (8-kiln dry process plant at Egypt), and Coplay Cement Manufacturing Co. (3-kiln dry process plant at Coplay). Output was general use and high-early-strength types for shipments chiefly to consumers in eastern Pennsylvania, New York, New Jersey, Virginia, and Delaware. The leading consumers were ready-mixed concrete companies and building material dealers.

Coplay Cement Manufacturing Co., Coplay, The Whitehall Cement Manufacturing Co., Cementon, Lehigh Portland Cement Co., Fogelsville, and Giant Portland Cement Co., Egypt, quarried and crushed cement rock at local plants and utilized the stone for manufacturing

cement. Roy J. Kern, Schnecksville, Eastern Lime Corp., Stiles, and Lehigh Stone Co., Ormrod, quarried and crushed limestone chiefly for concrete aggregate and roadstone. Dimension slate was quarried near Slatedale by Penn Big Bed Slate Co., Inc., for sale for a wide variety of uses chief among which were structural and sanitary, blackboards, billiard table tops, and flagging.

Semiprecious agates, quartz crystals, and corundum, were collected near Friedensville. Crude perlite shipped from mines in Colorado, was expanded by Pennsylvania Perlite Corp. The material was marketed mainly as plaster aggregate, loose-fill insulation, and soil conditioning.

Luzerne.—Anthracite production increased 11 percent. The number of men employed increased slightly to 4,684. The county was the first ranking area in anthracite production with output of 6.8 million tons. Leading producers were Glen Alden Corp., Lehigh Valley Anthracite, Inc., Susquehanna Coal Co., Jeddo-Highland Coal Co., George Rancho, and Hudson Realty Co., Inc.

There was a 75-percent increase in crushed sandstone production to meet the aggregate requirements of new highway projects in the area. Producers were Coolbaugh Sand & Stone Co., Inc., Dupont, General Crushed Stone Co., White Haven, and American Asphalt Paving, Shavertown. Coolbaugh Sand & Stone Co., Inc., installed a twin-jaw crusher.

Sand and gravel production increased 7 percent in 1963. The chief market was paving aggregate. Six operations were active, the leading of which were Airport Sand & Gravel Co., Inc., Wyoming, Frank B. Sgarlat Sand & Gravel Co., Forty Fort, and J. A. & W. A. Hess, Inc., Nescopeck.

The county led in value of peat production increasing 9 percent from that of 1962. Humus peat was recovered from a bog near White Haven by Blue Ridge Soil Pep Co., Inc., and was sold in bulk. Moss, reed-sedge, and humus peat was recovered from bogs near White Haven by Pennsylvania Peat Moss, Inc.

The Hazelton Brick Co. mined miscellaneous clay near Hazelton for manufacturing building brick.

Lycoming.—Lycoming Silica Sand Co. quarried and crushed limestone at its Lime Bluff quarry, Muncy, and Pine Creek quarry, Jersey Shore, chiefly for concrete aggregate and roadstone. In addition, crushed limestone for agstone was produced at the company's Pine Creek quarry. Susquehanna Quarry Co. operated a quarry and portable plant near Jersey Shore to produce limestone for road-building material. Some of the stone was sold to Government agencies for road construction. Small quantities of dimension sandstone for rough construction and flagging were produced. Crushed slate was crushed and ground to flour by Keystone Filler Manufacturing Co., Muncy.

Lycoming Silica Sand Co. produced chiefly building and paving sand and gravel at a stationary plant near Montoursville. Some industrial sand also was produced.

Only three coal mines were active, two of which were strip mines where 93 percent of total output was mined. Three power shovels, two draglines, and two bulldozers were in use at these pits.

Penn Paint & Filler Co., Antes Fort, and Keystone Filler & Manufacturing Co., Muncy, quarried tripoli (rottenstone). After crushing, drying, and pulverizing, the material was marketed for use as an abrasive and filler.

McKean.—Hanley Co. mined miscellaneous clay at Lewis Run for manufacturing heavy clay products. Kness Brothers mined fire clay at Mt. Jewett for sale to foundries and steelworks.

Three small coal strip mines were active. C. L. McGavern produced sand for open-hearth furnaces at Eldred.

Mercer.—Twelve strip mines were in operation producing almost 1 million tons of coal, but this was a 13-percent decrease below 1962. No underground mines were active in 1963. Equipment in use at the strip mines included 15 power shovels, 14 draglines, 23 bulldozers, and 1 carryall scraper. One pneumatic preparation plant was in operation, but 19 percent of county output was cleaned (some in Butler County). Of total output one-third was crushed but there was no treatment.

Sand and gravel production increased 45 percent responding to increased demand for paving aggregate. Producers were Seidle Sand & Gravel Co., Mercer, Transfer Sand & Gravel Co., South Pymatuning, and Taylor Sand & Gravel Co., Big Bend.

Crushed sandstone for sales to a wide variety of consumers was quarried by White Rock Silica Sand Co. near Greenville. Arthur J. Gobbie quarried dimension sandstone near Leesburg for rough construction uses. This company installed a new quarry derrick.

Mifflin.—Ganister for silica brick was produced by Haws Refractories Co. at Hawstone. The Pennsylvania Glass Sand Corp. produced industrial sand at its Hatfield Works near McVeytown. Output was chiefly grinding and polishing and glass sand. Three other operations, producing chiefly building or paving material, also were active.

Crushed limestone, chiefly for use as blast-furnace flux, concrete aggregate and roadstone, and stone sand, was quarried by Bethlehem Limestone Co. at its Naginey quarry. The company improved its plant by installing an impact crusher and a covered storage bin. George E. Miller Coal Co., McVeytown, quarried limestone for concrete aggregate and road material. Honey Creek Lime Co., Reedsville, and Ehrenzeller Lime Co., McVeytown, quarried and crushed limestone for manufacturing aglime.

Monroe.—Crushed and broken limestone for use as concrete aggregate, road material, and the manufacture of cement, was produced by Hamilton Stone Co., Inc., Bossardsville. Some of the stone was sold to the State highway department for road construction.

Sand and gravel entirely for building uses was produced by Sheesley's Minerals, Inc., Kunkletown and Javelyn Mobile Mix, Inc., Stroudsburg.

The Universal Atlas Cement Division, United States Steel Corp., mined miscellaneous clay at Kunkletown for its own use in cement manufacture. A quantity of mineral specimens, including petrified corals, were collected near Stroudsburg. No peat production was reported in 1963.

Montgomery.—Production of stone exceeded 4 million tons, and the county continued to rank second as a stone-producing area. Quarries

were operated near Conshohocken by Glasgow Quarry, Inc., and near Norristown by Bradford Hills Quarry, Inc., to produce crushed and broken limestone for concrete aggregate and roadstone. Limestone quarried and crushed near West Conshohocken by Allentown Portland Cement Co. was used for manufacturing cement. Quarries operated near Plymouth Meeting by G. & W. H. Corson, Inc., and near Bridgeport by Bethlehem Limestone Co. produced crushed limestone mainly for flux in iron and steel plants, concrete aggregate, road material, lime manufacture, and in magnesium-metal plants. Firestone Products Co., Inc., quarried crushed and dimension sandstone at Glenside, the former for refractory and roofing granule uses, the latter for rubble and rough architectural uses. William Bambi & Sons, Inc., quarried irregular shaped facing and other stone near Norristown.

Mignatti Construction Co., Inc., produced crushed granite for concrete aggregate plus a quantity of dimension stone near Bethayres. Crushed basalt for concrete aggregate and roadstone was produced by Montgomery Stone Co., Inc., Montgomeryville, R. K. Kibblehouse, Perkiomenville, and Pottstown Trap Rock Quarries, Inc., Sanatoga. Montgomery Stone Co., also quarried dimension basalt for both rough and dressed construction uses. R. K. Kibblehouse installed a new crusher, screens, and storage bins.

Allentown Portland Cement Co. operated its three-kiln wet process plant at West Conshohocken producing both portland and masonry cements. Shipments of portland cement were slightly higher than in 1962, but price cuts reduced cash income from these sales. Production was entirely the general-use type which was shipped by both rail and truck, mostly in bulk form, to ready-mixed concrete companies in eastern Pennsylvania.

G. & W. H. Corson, Inc., produced mostly hydrated lime at Plymouth Meeting for consumption as Mason's lime and for the chemical market.

Clay production dropped significantly. Fire clay had been produced in 1962, but output in 1963 was entirely miscellaneous clay. Producers were The Robinson Clay Product Co. (vitrified sewer pipe), Pottstown; Philadelphia Brick Co. (heavy clay products), Trappe; and The Keller Pottery Co. (pottery), North Wales. The Philadelphia Brick Co. reported installation of a new power shovel and loader.

A small quantity of building sand was produced near Norristown. Zeolite and lead ore mineral specimens were collected in the county. Refractory & Insulation Corp., Port Kennedy, expanded crude perlite shipped from mines in Colorado. The Phillip Carey, Plymouth Meeting, perlite expanding plant was dismantled during the year.

Montour.—Lycoming Silica Sand Co., Milton, produced limestone for concrete aggregate, roadstone, and agstone. Mausdale Quarry Co., Danville, quarried and crushed limestone for concrete aggregate and roadstone. A small quantity of sand and gravel was produced at two pits near Danville.

Northampton.—The county continued as first ranking in production of both portland and masonry cement with shipments of almost three times the next ranking county. Ten cement plants with a total of 51 kilns were in operation with capacity to produce 26.5 million barrels.

Three plants were located at Nazareth, two at Bath, two at Northampton, and one each at Martins Creek, Stockerton, and Broadhead. Lehigh Portland Cement Co.'s Sandt's-Eddy plant was shut down. Three of the plants used the wet process; seven used the dry process. Keystone Portland Cement Co. at Bath was the largest producer in 1963. Production of portland cement was reduced by 3 percent, and the average value per barrel dropped from $3.29 to $2.98. Masonry cement sales and prices also were reduced. Most of the portland cement production was the general-use type, but significant quantities of high-early-strength cement also were produced. Shipments, which were almost evenly divided between trucks and the railroad, were chiefly to consumers in eastern Pennsylvania, New Jersey, New York, and the New England States. Ready-mixed concrete companies were the largest consumers. Penn Dixie Cement Co. took its No. 6 plant out of operation in 1963. Alpha Portland Cement Co.'s Martins Creek plant suffered fire damage to its powerhouse section. Whitehall Cement Manufacturing Co. was in the midst of a large-scale improvement plan which involved replacement of considerable equipment. Capacity of white portland cement was expected to be increased.

Northampton County continued as the leading stone-producing county although production dropped to 4.9 million tons, compared with 5.5 million tons in 1962. Nine cement firms produced cement rock from quarries near Nazareth (three), Northampton (two), Bethlehem (one), Bath, Stockertown, and Martins Creek for cement manufacture. In addition to the cement companies, limestone quarries were operated by Bethlehem Steel Co., Bethlehem, and The Trumbower Co., Inc., Nazareth, and crushed stone was sold for riprap, stone sand, agstone, and railroad ballast. The county was the center of the State's slate industry with production valued in excess of $3.5 million. Nine quarries were operated; the larger of which in terms of value of output were Anthony Dally & Sons, Inc., Stephens-Jackson Co., D. Stoddard & Sons, Inc., Diamond Slate Co., and Doney Slate Corp., all of Pen Argyl. Slate output was mainly for flagging, for structural and sanitary uses, for blackboards, and for roofing. Production decreased slightly but values increased. Crushed slate also was produced from slate waste. Pennsylvania Lightweight Aggregate, Inc., processed waste slate into lightweight aggregate at a new rotary-kiln plant near Bangor.

Sand and gravel production increased slightly to meet increased demand for building aggregate. Houdaille Construction Materials, Inc., Portland; W. J. Lowe & Sons, Inc., Bangor; and Lehigh Valley Sand & Gravel Co., Inc., Easton, produced in 1963.

Northumberland.—Anthracite production increased 24 percent to 2.0 million tons. This was reflected in the 42-man increase in employment to 1,912 men. The leading producers were the Susquehanna Coal Co., Reading Anthracite Co., and Rosini Coal Co.

Clay production, which was entirely miscellaneous clay chiefly for building brick manufacture, increased over that of 1962. The leading of three producers was the Glen-Gery Shale Brick Corp. at Watsontown. This company reported the installation of automatic pugging equipment and new equipment for the clay pit.

Limestone quarried near Herndon and Northumberland was crushed for use as road material, agstone, and for agriculture lime manufacture.

Perry.—Bradford Hills Quarry, Inc., Newport, quarried and crushed limestone for concrete aggregate and roadstone. Most of the stone was sold to the State highway department and local townships for road construction.

Philadelphia.—Reduced production of building sand and gravel was reported by The Liberty Corp. at its dredging operation on the Delaware River near Philadelphia.

Gulf Oil Corp. recovered sulfur as a byproduct in the liquid purification of oil refinery gas at its Philadelphia plant using the Claus process. Atlantic Refining Co. recovered hydrogen sulfide by the Girdler system, using diethanolamine and monethanolamine, for use in sulfuric acid manufacture.

Potter.—Dimension sandstone was produced at eight quarries for use chiefly as flagging. The leading producers were Penn Kress Flagstone Co., Austin, and Rummings & Wright, Wharton.

Schuylkill.—Anthracite production in the second-ranked producing county increased 5 percent to 6.5 million tons, but employment dropped by 269 to 4,873 men. The leading anthracite producers were Reading Anthracite Co., Greenwood Stripping Co., Mammoth Coal Co., Honeybrook Mines, Inc., Gilberton Coal Co., and Lehigh Valley Anthracite, Inc.

Russ Contracting Co., Andreas, and Pennsylvania Aggregates, Inc., Summit Station, produced limestone for use as concrete aggregate and roadstone. Crushed sandstone was produced by Summit Quarries, Inc., Summit Station, for the aggregate market and by Harbison-Walker Refractories Co. at the Andreas quarry for silica brick.

Refractory Sand Co., Inc. produced paving sand and sand for furnace bricks at a stationary plant near Andreas.

Miscellaneous clay was mined by three producers. The leading producer was Lehigh Materials Co. which produced lightweight aggregate from shale supplied by various producers. Building brick was produced by the other clay mining companies.

Snyder.—National Limestone Quarry, Middleburg, quarried and crushed limestone for use as road materials and agstone. Carton L. Comfort, Mount Pleasant Mills, produced crushed limestone and manufactured agricultural lime.

Central Builders Supply Co. produced building sand and gravel and paving sand at a stationary plant near Selinsgrove. Anthracite production increased slightly. Miscellaneous clay was mined by the Paxton Brick Co., near Paxtonville, for building brick.

Somerset.—Coal production increased 29 percent chiefly due to increased strip-mined production as 14 new strip mines were in operation. Three less underground mines were active but production increased slightly. Of total production 58 percent was mined at 49 strip pits, 41 percent at 78 underground mines, the balance at 2 auger mines. One additional continuous miner was in use bringing the total to seven. In addition, 2 mobile loaders and 27 hand-loaded face conveyors were active. Overall, 71 percent of underground production was loaded mechanically. Strip mining equipment included 82 power shovels, 50 draglines, and 84 bulldozers. The county was third rank-

ing in strip coal production. No cleaning plants were in operation.

Almost doubled output of fire clay was reported mainly to meet the refractory demands of the steel industry. Eight pits were active, three of which were operated by General Refractories Co., one at Fort Hill and two at Rockwood. Other large producers included C. Brant Mining Co., Somerset, and Hiram Swank's Sons, Inc., Holsopple.

Somerset Limestone Co., Inc., quarried and crushed limestone at its Bakersville quarry for road material. Keystone Lime Co., Springs, produced crushed limestone for use as concrete aggregate, roadstone, and agstone. Crushed sandstone for aggregate was produced by Detwilers Industries, Inc., Central City, and Clarence Rodamer, Springs. A small quantity of sand and gravel was produced near Berlin and Boswell.

Sullivan.—Anthracite production decreased slightly below that of 1962. Only 11 men were employed by the industry, a drop of 8 from employment in 1962.

Susquehanna.—Crushed sandstone for aggregate was produced by Keelor Supply Co., Inc., Clifford, and Susquehanna Quarry Co., Montrose. Dimension sandstone chiefly for flagging was produced at a rate more than four times greater than in 1962 by six producers. The leading were Powers & Powers, Birchardville, and Susquehanna Bluestone Co., Susquehanna. Keelor Supply Co., Inc., installed a blacktop plant at its quarry. Three of the dimension sandstone producers reported installing new equipment.

No production of anthracite was reported.

Tioga.—Most of the county's coal production was mined at five strip mines; one small hand loading underground mine also was active. Stripping equipment included 16 power shovels, 8 draglines, and 13 bulldozers.

A small quantity of dimension sandstone was quarried in Elk Township.

Union.—Limestone, crushed chiefly for concrete aggregate and roadstone, was quarried near Winfield and Mifflinburg. The State highway department purchased some of the stone for road construction.

Venango.—Coal production more than doubled. Eleven strip mines and two auger mines were active compared with six strip mines and no auger mines in 1962. Stripping equipment included 23 power shovels, 9 draglines, 22 bulldozers, and 2 carryall scrapers. A jig preparation plant cleaned about one-third of total output.

Industrial Silica Division, Pennsylvania Glass Sand Corp., produced molding and fire or furnace sand at its Venango Works near Utica. Three other operations were active producing building and paving material, the largest of which was Oil City Sand & Gravel Co.'s dredging operation near Oil City.

Warren.—Sand and gravel production increased 34 percent. Output, mostly for building and paving, was reported by General Concrete Products Corp., Nelson & Ellberg, and Warren Sand & Gravel Co., Inc., all located near Warren.

Washington.—The county was the leading coal producing area with production of 12.2 million tons, an increase of 11 percent over 1962. Most of the output (93 percent) was from 21 underground mines, the balance from 14 strip mines and 3 auger mines. Almost all of the

underground production was loaded mechanically. A decrease of 9 was recorded in number of continuous mining machines in use (63), but the number of mobile loading machines (69) remained constant. Stripping equipment included 26 power shovels, 7 draglines, 29 bulldozers, and 4 carryall scrapers. Nine cleaning plants were in operation preparing 83 percent of total output. In addition, 53 percent was crushed and 9 percent was treated.

Crushed and broken limestone for use as road material was quarried near Washington by Washington Stone Co. Fire clay was recovered in conjunction with the limestone mining. Crushed sandstone for aggregate was quarried by Fry Coal & Stone Co. at a portable plant near Claysville.

Wayne.—Crushed sandstone for aggregate was quarried by Wayne Concrete & Sand Works, Inc., at Lake Ariel. Dimension sandstone chiefly for flagging was quarried by W. R. Strong & Son and Sterling Quarries, Inc.

A small quantity of anthracite was produced in 1963. Wayne Peat Humus Co. recovered moss and humus peat from bogs near Roaring Brook. Sand and gravel was produced by two operators near Lake Ariel.

Westmoreland.—Coal production increased 8 percent. Increased output of underground-mined coal was reported, even though five fewer mines were in operation. Seven new strip mines were opened. Of total production, 95 percent was mined at 37 underground mines, the balance at 31 strip mines and 1 auger mine. In use at the underground mines were 8 less continuous miners (14) and 2 less mobile loaders (26). Of underground output 98 percent was mechanically loaded. Six cleaning plants prepared 79 percent of total output. Three of these plants had thermal drying equipment. In addition, 52 percent was crushed and 28 percent was treated chiefly with oil.

Limestone was quarried and crushed for road material near Penn and Lower Burrell. Agricultural Lime & Stone Co., Derry Township, (a new producer) produced and crushed limestone for use as concrete aggregate, roadstone, agstone, and for manufacturing aglime. The county led in crushed sandstone production with output of almost 650,000 tons. Producers were Latrobe Construction Co., Ligonier, Eidemiller Enterprises, Inc., Lycippus, J. M. Hall and J. M. Hall, Jr., Inc., Baggaley, and Clayton H. Remaley, Murrysville. Dimension sandstone flagging was quarried by Lynns Quarry, and John C. Beaumont quarried sandstone rubble, both at Belle Vernon.

Wyoming.—J. G. Robinson, Inc., produced dimension sandstone (bluestone) near Fort Washington for flagging. Sand and gravel mainly for building and paving was produced by Wyoming Sand & Stone Co., and East Falls Sand & Gravel, both at Falls.

York.—Portland and masonry cement was produced by Medusa Portland Cement Co. at York. A $7 million reconstruction was completed at the plant. Original capacity was practically doubled. The old gray cement plant was dismantled, and current capacity was in white cement.

York County ranked fourth in stone production in 1963 as compared with fifth place in 1962. Limestone was produced at 10 operations, 6 near York, 2 near Thomasville, and 1 each near Mount Wolf

and Wrightsville. Chief uses of the crushed stone were as concrete aggregate, roadstone, open-hearth and blast-furnace flux, the manufacture of cement and lime, and agstone. Smaller quantities were sold or used for glassmaking, asphalt fill, whiting, and mineral food. The Ruberoid Co. produced crushed slate for granules and flour at a quarry and plant near Delta.

Dead-burned dolomite was produced by The J. E. Baker Co., near York, mainly for consumption within the State but with sales to other Eastern States plus exports.

Glen-Gery Shale Brick Corp and Medusa Portland Cement Co. mined miscellaneous clay near York. The former company produced building brick and the latter used the clay in cement manufacture.

Building sand and gravel and paving sand was produced by Pennsy Supply, Inc., York Haven, and building sand was produced by Neuman Sand & Supply Co., York.

Pennsylvania Perlite Corp., York, expanded crude perlite shipped from Colorado mines. General Mining Associates, Glenville, was the only mica producer in the State. The scrap mica was sold mostly for use in paints, rubber, and welding rods.

The Mineral Industry of Puerto Rico, the Panama Canal Zone, the Virgin Islands, and Pacific Island Possessions

The Puerto Rico section of this chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Mineralogy and Geology Section, Industrial Research, Economic Development Administration, Commonwealth of Puerto Rico for collecting information on all minerals.

By Harry F. Robertson,[1] José F. Cadilla,[2] Leovigildo Vázquez [3] and Roy Y. Ashizawa [4]

PUERTO RICO [5]

VALUE of mineral production in Puerto Rico increased to a record $41 million, approximately 7 percent over that of 1962. Construction materials, represented by cement, sand and gravel, and stone, comprised about 54 percent, 25 percent, and 20 percent, respectively, of total value. Clays, lime, and salt accounted for the remaining 1 percent.

TABLE 1—Mineral production in Puerto Rico [1]

Minera		1962		1963	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement	thousand 376-pound barrels	6,347	$20,018	7,217	$22,090
Clays	thousand short tons	219	131	200	158
Lime	do.	1	14	4	103
Salt	do.			8	131
Sand and gravel	do.	7,378	9,793	7,616	10,407
Stone	do.	5,589	8,551	5,334	8,237
Total			38,507		41,126

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[1] Supervising mining engineer, Bureau of Mines, Bartlesville, Okla.
[2] Chief, Mineralogy and Geology Section, Economic Development Administration, Commonwealth of Puerto Rico.
[3] Geologist, Mineralogy and Geology Section, Economic Development Administration, Commonwealth of Puerto Rico.
[4] Mineral specialist, Bureau of Mines, San Francisco, Calif.
[5] Prepared by Harry F. Robertson, José F. Cadilla, and Leovigildo Vázquez.

A 9.6-percent increase in net income in 1963 indicated that the Puerto Rican economy continued to grow. The amount invested in public and private housing during 1963 increased about 19 percent over that invested in 1962. Most of the housing construction was in the greater San Juan area, chiefly because of the influx of population into the area. Highway construction continued at about the same level.

Exports from Puerto Rico in 1963 reached a record $845 million. About 97 percent of Puerto Rican exports go to the United States. Value of imports into Puerto Rico totaled about $1.2 billion, a 9-percent gain compared with the value in 1962. Mineral fuels, metals, and other raw and processed mineral products comprised about 23 percent of total value. Crude and unfinished oil imports from Venezuela and Netherlands Antilles increased 12 percent to an average 106,950 barrels per day. Imported oil was processed by the two Puerto Rican oil refineries.

Exploration for various minerals in the Island's mountainous interior continued. Active companies were Ponce Mining Co. (a subsidiary of American Metal Climax, Inc.), south of Utuado; Bear Creek Mining Co., southeast of Lares; and Newmont Exploration Co., Ltd., in the La Muda area south of San Juan. Ponce Mining Co. was driving an exploratory tunnel near Utuado to test a potential copper ore deposit.

The U.S. Atomic Energy Commission (AEC) and the Puerto Rico Water Resources Authority continued constructing the nuclear power-plant near Rincón, Aguadilla District. In late December, AEC announced approval to start operating the nuclear reactor. The plant produces superheated steam within the reactor core for generating about 16,300 kilowatts of electricity. Total cost of the plant was about $18.3 million.

New aerial photographs of Puerto Rico and the offshore islands were taken during the first half of 1963. The Soil Conservation Service of the U.S. Department of Agriculture and the Geological Survey of the U.S. Department of the Interior conducted and financed the project. The Federal Geological Survey, working under a cooperative agreement with Puerto Rico Economic Development Administration, completed geologic mapping of three quadrangles; work continued on mapping more quadrangles.

During 1963, geologic maps of Vega Alta [6] and Camuy [7] were published. The Puerto Rican Department of Public Works, in cooperation with the Federal Bureau of Public Roads, was conducting a comprehensive and systematic survey of construction materials of Puerto Rico. Reports on Carolina [8] and Vega Alta [9] quadrangles were published. Similar reports on the Caguas, Bayamón, San Juan, Aguas Buenas, Gurabo, Naranjito, and Fajardo quadrangles were being prepared.

---

[6] Monroe, W. H. Geology of the Vega Alta Quadrangle, Puerto Rico, U. S. Geol. Survey Map GO–191, 1963.

[7] ———. Geology of the Camuy Quadrangle, Puerto Rico, U.S. Geol. Survey Map GQ–197, 1963.

[8] Perry, A. O., and P. A. Gelabert. Construction-Material Resources of the Carolina Quadrangle, Puerto Rico. P.R. Dept. of Public Works Geol. Inv. Bull. 1, 1963.

[9] Perry, A. O. Construction-Material Resources of the Vega Alta Quadrangle, Puerto Rico. P.R. Dept. of Public Works Geol. Inv. Bull. 2, 1963.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—The Puerto Rican cement industry was again the major contributor to the total value of mineral production in Puerto Rico. Shipments of portland cement totaled 7.2 million barrels, a 14-percent increase over that of 1962. A substantial increase in exported cement accounted for the record shipments. Decreased unit value prevented a corresponding rise in total value.

TABLE 2.—Portland cement production and shipments

Year	Production (barrels)	Shipments		Unit value
		376-pound barrels	Value (thousands)	
1954–58 (average)	4,678,071	4,470,792	$13,728	$3.07
1959	5,324,188	5,392,312	16,982	3.15
1960	5,415,086	5,441,497	14,546	2.67
1961	6,070,140	5,931,420	16,946	2.86
1962	6,364,736	6,346,662	20,018	3.15
1963	7,171,302	7,217,417	22,090	3.06

The two Puerto Rican cement plants, Ponce Cement Corp. and Puerto Rico Cement Corp., merged and became Puerto Rican Cement Co., Inc.

Domestic demand for cement decreased. To compensate, exports of Puerto Rican cement increased 53 percent; imported cement decreased 11 percent and accounted for a lesser share of shipments of cement within Puerto Rico. Total stocks of cement at the two plants decreased to 180,000 barrels. The plants operated at an average 96 percent of capacity.

Puerto Rican Cement Co., Inc., announced plans to build a new plant to produce white cement. The plant will produce a premium-grade cement at an estimated rate of 350,000 bags annually.

Clays.—Most of the clay output was used in manufacturing cement. Minor quantities were used in studio potteries and in manufacturing heavy clay products. Total clay used by the two cement manufacturers and the clay products plant was about 9 percent less than that reported in 1962. A substantial quantity of sandy clay used for fill and various construction products was not included.

Diazlite, Inc., near San Juan, the first plant in Puerto Rico to produce expanded clay aggregate for the building industry, was completed in Trujillo Alto. Initial capacity of the plant was about 650 cubic yards per day. Company plans included exporting the lightweight aggregate to the Virgin Islands in addition to supplying Puerto Rican demands.

Lime.—The Puerto Rican Cement Co., Inc., lime plant at Ponce was completed in August and began producing at a rate of 20,000 tons of lime per year, less than half its full capacity of 45,000 tons. By yearend, the plant had produced about 3,600 tons of hydrated lime. Output of the plant was used for water purification and softening, sugar processing, and various purposes in the construction industries.

The South Puerto Rico Sugar Corp. was active during the year and produced about 600 tons of quicklime for use in processing sugar.

Salt.—Salt production in Puerto Rico during 1963 was severely affected by heavy rains that fell during the hurricane season. According to producers, about half of the prospective 1963 harvest was lost and major repairs were necessary on several salt ponds. Located in the extreme southwestern part of Puerto Rico, the salt ponds were operated by Puerto Rico Salt Works, Inc., Ponce Salt Industries, Inc., Carlos Ramírez Acosta, and Abel Carlo. Total production in 1963 was about 6,000 tons. The locally produced salt was used in tannery and in industrial operations related to fishing and fish canning. Ponce Salt Industries, Inc., imported about 12,000 tons of salt from Gran Inagua for refining to table salt.

Sand and Gravel.—Production of sand and gravel increased 3 percent in quantity and 6 percent in total value. Most of the sand and gravel produced in 1963 was higher value material used in public and private housing construction and highway building and maintenance. Use of white high-grade silica sand from inland beds west of San Juan was continued for cement manufacturing, glass, ceramics, foundries, and abrasives.

TABLE 3.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	1,746	$2,711	1,856	$2,916
Paving	1,614	1,600	1,699	1,713
Fill	513	325	419	262
Other	102	108	29	54
Total sand	3,975	4,744	4,003	4,945
Gravel:				
Building	1,195	2,213	1,312	2,457
Paving	989	1,852	1,018	1,981
Fill	305	197	361	241
Other	167	155	138	119
Total gravel	2,656	4,417	2,829	4,798
Total sand and gravel	6,631	9,161	6,832	9,743
Government-and-contractor operations:				
Sand:				
Building	5	7	----	----
Paving	182	178	196	186
Fill	434	322	453	344
Total sand	621	507	649	530
Gravel:				
Building	6	8	----	----
Paving	20	34	18	30
Fill	100	83	117	104
Total gravel	126	125	135	134
Total sand and gravel	747	632	784	664
Grand total	7,378	9,793	7,616	10,407

Dredging operations continued in San Juan Harbor; at yearend, the job was about 71 percent completed. The purpose of the project was to deepen the channel 6 to 8 feet to new depths of 36 to 46 feet. About 12 million cubic yards of material will be removed to deepen the harbor.

Stone.—Limestone, classified as marble in many deposits, was produced in all seven districts. Andesite, tuffaceous siltstone, and miscellaneous volcanic stone were produced in all districts except Arecibo. Granite was produced in Humacao District and Guayama District. Basalt was produced in Mayaguez District. Stone output was 73 percent crushed limestone, 2 percent crushed granite, and 22 percent crushed miscellaneous stone. The remaining 3 percent was rough dimension stone and crushed marble. Most of the crushed limestone was used in cement manufacturing, concrete aggregate, road base, and fill. Crushed marble was used in making terrazzo. The two cement plants reported the largest crushed stone output, totaling about 1.9 million tons.

TABLE 4.—Stone sold or used by producers

Year	Dimesion limestone		Crushed limestone [1]		Miscellaneous stone		Total	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1954–58 (average)	117,580	$236	1,868,319	$2,486	27,484	$53	2,013,383	$2,775
1959	10,322	23	1,980,840	2,693	72,000	162	2,063,162	2,878
1960	36,941	87	3,474,462	5,938	708,080	1,636	4,219,483	7,661
1961	[2] 77,133	213	3,718,011	4,546	1,253,524	2,525	5,048,668	7,284
1962	60,787	130	4,269,840	5,829	1,258,080	2,592	5,588,707	8,551
1963	64,647	152	3,918,381	5,306	1,350,510	2,779	5,333,538	8,237

[1] Includes limestone for cement and lime.
[2] Includes dimension marble.

MINERAL FUELS

Record quantities of crude petroleum imported from Venezuela were refined by the Cataño plant of Caribbean Refining Co., San Juan District, and Commonwealth Oil Refining Co., Mayaguez District. Output of these refineries was used in the growing chemical complex developing in Puerto Rico.

TABLE 5.—Value of mineral production in Puerto Rico, by districts

Senatorial district	1962	1963	Mineral products produced in order of value
Aguadilla	$1,322,185	$1,371,600	Stone, sand and gravel.
Arecibo	1,211,715	1,130,155	Do.
Guayama	1,525,780	1,184,525	Sand and gravel, stone, clays.
Humacao	731,798	777,259	Stone, sand and gravel.
Mayaguez	2,194,189	2,497,058	Sand and gravel, stone, salt, lime.
Ponce	12,472,442	13,466,927	Cement, sand and gravel, stone, lime, clays.
San Juan	19,049,201	20,698,476	Cement, sand and gravel, stone, clays.
Total	38,507,310	41,126,000	

Commonwealth Oil Refining Co. began expanding its refinery near Ponce. The first step, costing about $5.1 million, would increase daily processing capacity to about 115,000 barrels, up from the present 90,000 barrels. Completion of the project was scheduled for early 1964. The company also announced plans to build a $23 million petrochemical plant in Puerto Rico. The plant would produce inorganic compounds from petroleum feedstocks, principally benzene, toluene, and xylene. It will be built near the company's oil refinery at Guayanilla Bay near Ponce. Completion was scheduled for early 1965.

METALS

Industrial Siderurgica, Inc., produced reinforcing bars from domestic and imported iron and steel scrap. Expansion of this plant progressed during the year. Added facilities would include a 500-ton scrap shear and two 20-ton electric arc melting furnaces. A two-strand continuous casting machine would be installed in conjunction with the furnaces. This casting machine would be capable of converting molten steel directly into a continuous 4-inch or 6-inch billet for drilling, reinforcing, and merchant bar products.

Danrich Steel Co., Inc., was planning to construct a steel reinforcing rod plant.

PANAMA CANAL ZONE [10]

The mineral industry of Panama Canal Zone was less active in 1963 than in 1962. This was indicated by the 16-percent decrease in overall value of mineral production. Sand and gravel was produced by Panama Sand Co., Inc. Basalt and miscellaneous stone production decreased 22 percent in quantity and caused the drop in total value.

VIRGIN ISLANDS [11]

Reported production of basalt in the Virgin Islands was much greater than the 1962 level. A. C. Samford Corp. was the major stone producer. The stone was used principally for concrete aggregate, roadstone, and riprap.

TABLE 6.—Mineral production in the Panama Canal Zone and Virgin Islands [1]

Mineral	1962		1963	
	Short tons	Value	Short tons	Value
Canal Zone:				
Sand and gravel	70,268	$76,914	83,633	$87,057
Stone [2]	207,373	359,173	161,501	281,021
Total		436,087		368,078
Virgin Islands:				
Stone (basalt)	21,273	82,348	65,973	328,919

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Includes basalt.

[10] Prepared by Harry F. Robertson.
[11] Prepared by Harry F. Robertson.

TABLE 7.—Sand and gravel sold or used by producers in the Panama Canal Zone

Year	Short tons	Value
1954–58 (average)	23,402	$26,104
1959	14,392	20,500
1960	65,000	68,149
1961	75,204	73,274
1962	70,268	76,914
1963	83,633	87,057

TABLE 8.—Crushed basalt and miscellaneous stone sold or used by producers in the Panama Canal Zone

Year	Short tons	Value
1954–58 (average)	146,810	$209,989
1959	223,348	270,085
1960	203,355	305,914
1961	162,704	270,780
1962	207,373	359,173
1963	161,501	281,021

TABLE 9.—Crushed basalt sold or used by producers in the Virgin Islands

Year	Short tons	Value
1954–58 (average)	10,640	$33,121
1959	14,429	50,616
1960	14,895	51,287
1961	20,302	75,399
1962	21,273	82,348
1963	65,973	328,919

Harvey Aluminum, Inc., announced plans to utilize a water-desalting facility to convert sea water into vast quantities of fresh water needed to process alumina. Design capacity of the facility was 750,000 gallons of water per day. The process features an advanced-design flash evaporator, using tubing and plate made of titanium. The plant would be at St. Croix and would provide fresh water and electricity to supplement that produced by the sea water conversion and electric turbogenerating plant at Krum Bay. The existing plant averages about 300,000 gallons of fresh water per day.

Dredging of Charlotte Amalie Harbor was completed in mid-1963. A total of 800,000 cubic yards of sand and coral was removed from the bottom of the harbor and used as fill to reclaim 37.5 acres of land for industrial and commercial purposes. The dredging eliminated a shoal in the harbor that had seriously restricted the moving of large vessels. Minimum depth of the harbor was increased from 16 to 33 feet.

REVIEW BY ISLANDS [12]

American Samoa.—Substantial quantities of coral sand and basalt rock were quarried during 1963 for use in expanding public utilities, improving roads, and constructing new schools, housing units, and communications facilities. Public works crews utilized a dragline

[12] Prepared by Roy Y. Ashizawa.

to recover coral sand and operated a portable crusher at a basalt quarry.

Canton.—Federal Aviation Agency employees produced coral limestone for road maintenance and for stabilizing portions of the runway approaches.

TABLE 10.—Mineral production in the Pacific Island possessions

Area and mineral	1962		1963	
	Short tons	Value	Short tons	Value
American Samoa:				
Pumice (volcanic cinder)	50,490	$108,192		
Sand	2,717	3,705	76,680	$192,720
Stone (crushed)	1,103,113	1,787,830	944,372	2,351,112
Total		1,899,727		2,543,832
Canton: Stone (crushed)	130	500	1,560	6,000
Guam: Stone (crushed)	81,745	122,938	306,995	438,146
Wake: Stone (crushed)	4,880	40,750	8,585	50,500

Guam.—While rebuilding from a typhoon that occurred in November 1962, Guam was again struck by typhoon-scale winds and heavy rains in April 1963. Virtually all of the repair work and the temporary housing units built in the wake of the 1962 storm were severely damaged. Rehabilitation required large quantities of coral limestone. Commercial producers quarried and processed this material near Barrigada and Tumon. Coral pits in other areas were worked by government crews and contractors to obtain rubble for foundations and concrete aggregate for use in rebuilding roads, buildings, utilities, and sanitary facilities.

Wake.—Coral limestone was used by Wake Island crews and contractors in constructing a concrete jet-blast fence, hardstands, and building foundations, and for road maintenance.

Other Pacific Island Possessions.—No mineral production was reported on the Islands of Enderbury, Jarvis, Johnston, Midway, and Palmyra.

The Mineral Industry of Rhode Island

By Samuel A. Gustavson [1]

RHODE ISLAND mineral production was valued at about $2.8 million in 1963, 6 percent below the 1962 value. The chief factors contributing to the decrease were a continued decline in demand for granite riprap for construction of breakwater facilities and a lower production of sand and gravel for use as fill. Construction activity continued at a high level, especially on Interstate Routes 95 and 295. Providence County was the leading producing area.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 1.—Value of mineral production in Rhode Island, by counties [1]

(Thousands)

County	1962	1963	Minerals produced in 1963, in order of value
Kent	(2)	(2)	Sand and gravel.
Newport	$254	$31	Stone, sand and gravel.
Providence	1,381	1,733	Do.
Washington	330	380	Do.
Undistributed [3]	1,029	663	
Total	2,994	2,807	

[1] Bristol County is not listed because no production was reported.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes value of gem stones and sand and gravel (1962) not specified by counties.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$1,386	1958	$2,269
1953	1,537	1959	2,281
1954	1,524	1960	5,687
1955	1,914	1961	3,085
1956	1,647	1962	3,015
1957	1,391	1963	2,821

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

Water.—The Bureau of Mines canvassed mineral producers in 1963 for water usage in 1962. In Rhode Island, water use in the stone industry is chiefly for sawing and grinding dimension stone and sizing crushed stone. In the sand and gravel industry, water is used for washing to remove clay, wood chips, and other contaminants and in screening and sizing.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Commodity	New water	Water recirculated	Total water use	Water discharged	Water consumed	Gallons of new water per dollar value of production
Stone (quarries and mills)	67	----------	67	58	9	61
Sand and gravel	439	86	525	403	36	232
Total	506	86	592	461	45	169

REVIEW BY MINERAL COMMODITIES

NONMETALS

Gem Stones.—A variety of semiprecious stones and mineral specimens were collected from quarries and mine dumps, chiefly in the northern part of the State. Collectors recovered agate, actinolite, fluorescent calcite, and a variety of pegmatite minerals.

Sand and Gravel.—Output of sand and gravel was about 1.8 million tons valued at $1.8 million in 1963, compared with 2.3 million tons valued at $1.9 million in 1962. The difference is chiefly due to a significant decrease in demand for fill material. Moderate increases in requirements for building and paving sand and gravel and for molding sand were recorded. Most of the commercial production was used for building and paving (81 percent) and fill material (14 percent). The remainder was used for molding sand and other purposes. Most of the material was processed (81 percent). In 1962, with a higher proportion used as fill, only 62 percent was processed. The average value of commercial sand and gravel increased to $1.05 per ton in 1963, compared with $0.82 in 1962 and $0.97 in 1961. Most of the 18 commercial producers had stationary plants; their principal means of transportation was by truck. A small tonnage (less than 1 percent) was shipped by rail.

Stone.—Production of stone decreased 5 percent in tonnage and 12 percent in value from the 1962 figures. No production of granite riprap was reported and less than half the 1962 tonnage of crushed granite was produced, reflecting completion of some breakwater facilities. Limestone production was virtually unchanged, and miscellaneous stone output was up 17 percent in tonnage and 9 percent in total value. The limestone was used mainly as agstone (agricultural stone) and roofing gravel. Miscellaneous stone was quarried in Providence and Newport Counties and was used chiefly as concrete aggregate and roadstone. Some was used for riprap and railroad ballast. Crushed and broken granite was produced in Providence and Wash-

ington Counties. A limited quantity of granite was produced in Providence County by Government-and-contractor operations. Less dimension granite was produced in Washington County for construction and monumental purposes than in 1962. Granite quarried in Massachusetts and other States was processed into finished dimension stone at a fabricating yard in Providence County.

REVIEW BY COUNTIES

The State of Rhode Island, Division of Roads and Bridges, purchased sand and gravel. This sand and gravel was produced from many locations in the State. No mineral production was recorded for Bristol County in 1962 or 1963.

Kent.—Molding sand and sand and gravel for building, paving, fill, and ice control use were produced. Sales of sand and gravel for use as fill were somewhat less than in 1962, while overall sales for building and paving uses increased. Producers were Rhode Island Sand & Gravel Co. and Luigi Vallone, Inc., both near Warwick, and Whitehead Brothers Co., Washington.

Newport.—Peckham Bros. Co., Inc., produced conglomerate and paving sand and gravel at Middletown. The stone was crushed for concrete aggregate and roadstone. M. A. Gammino Construction Co. discontinued operation of its granite quarry at Tiverton in 1962.

Providence.—The value of mineral production from Providence County represented about 60 percent of the State's total. Most of the State's output of sand and gravel, limestone, and miscellaneous stone was from this county. Limestone was produced by the Conklin Limestone Co., Inc., at Lincoln. Most of it was crushed and sold for use as agstone, roofing gravel, blast-furnace flux, fertilizer filler, and caststone aggregate. Some dimension limestone was sold as rubble. Miscellaneous stone was produced at the Gammino quarry of M.A. Gammino Construction Co. Most of the stone produced was crushed and washed for use as roadstone and as an aggregate for ready-mixed concrete; some other uses were for filter beds, for dry walls, and as railroad ballast. About 10 percent of the company's output was for riprap. The company planned installation of a system of hydroclassifiers to separate stone dust into six sizes which would then be dried and blended to meet exact specifications. Most of this material was to be used in asphalt mixes for road surfacing. Operation of this installation was scheduled for April 1964. Some crushed granite was produced under contract for the State and used in highway construction.

Commercial sand and gravel output in the county increased 27 percent. Most of the output was washed, screened, or otherwise prepared for highway and construction use. Some sand was sold for ice control, foundry use, and concrete blocks. Transportation was all by truck. Producers included A. Cardi Construction Co., Inc., Del Bonis Sand & Gravel Co., and Andrews Sand & Gravel Co., at Cranston; Tasca Sand & Gravel Co. and J. Santoro, Inc., at Smithfield; Mack Sand & Gravel Co. and Forte Bros., Inc., at Cumberland; Town Line Sand & Gravel at Slatersville; L. Romano Construction Co. at East Providence; and Silvestri Bros., Inc., at Johnston.

Washington.—Westerly Granite Corp., at Bradford, and Gencarelli, Inc., at Westerly, produced dimension granite, rough and finished stone, chiefly for use as monuments and mausoleums. Tonnage output of dressed stone was less, but value was greater, than in 1962. Gencarelli, Inc., also produced granite for use as riprap. The value of this material was about the same as in 1962.

Tonnage of sand and gravel produced was slightly less than in 1962, but total value was virtually unchanged. Producers were South County Sand & Gravel Co. and Louis B. Schaeffer, both near Peace Dale, and James Romanella & Sons, Inc., near Westerly. Uses were chiefly for building and highway construction.

The Mineral Industry of South Carolina

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the South Carolina Geological Survey for collecting information on all minerals except fuels.

By Lawrence E. Shirley [1] and Henry S. Johnson, Jr.[2]

SOUTH CAROLINA continued its climb in the production of mineral commodities in 1963, establishing an alltime high record with a total value of $36 million. Total mineral production value increased over $2.5 million, for the second consecutive year, and was 8 percent greater than in 1962. The increase in value was attributed primarily to the rise in output of stone and sand and gravel. Leading commodities, in order of total value, were stone (crushed and dimension granite and crushed limestone), cement (masonry and portland), clays (Kaolin and miscellaneous), sand and gravel, and vermiculite. These five commodities accounted for 95 percent of the total value of mineral production.

TABLE 1.—Mineral production in South Carolina [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clay----thousand short tons	1,518	$7,165	1,491	$7,589
Gem stones	(2)	(2)	(2)	(2)
Sand and gravel----thousand short tons	3,318	3,670	4,051	4,750
Stone----do	6,382	10,066	7,262	10,926
Value of items that cannot be disclosed: Barite, cement, feldspar, kyanite, scrap mica, peat, pyrites, and vermiculite	----------	13,000	----------	13,214
Total	----------	33,901	----------	36,479

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Less than $500.

Commodities establishing record highs were masonry cement, miscellaneous clay, sand, and gravel, and kyanite. South Carolina, as in 1962, ranked second in the Nation in the output of kaolin, kyanite, and vermiculite. Less barite, kaolin, scrap mica, and dimension granite were produced than in 1962. Leading companies mining and processing minerals were Carolina Giant Division of Giant Portland

[1] Mining engineer, Bureau of Mines, Knoxville, Tenn.
[2] State geologist, South Carolina Geological Survey, Columbia, S.C.

Cement Co. (portland and masonry cement, miscellaneous clay, and limestone), Campbell Limestone Co. (crushed granite and limestone), J. M. Huber Corp. (kaolin), Becker County Sand & Gravel Co. (sand and gravel), Zonolite Division of W. R. Grace & Co. (vermiculite), and Palmetto Quarries Co. (crushed granite).

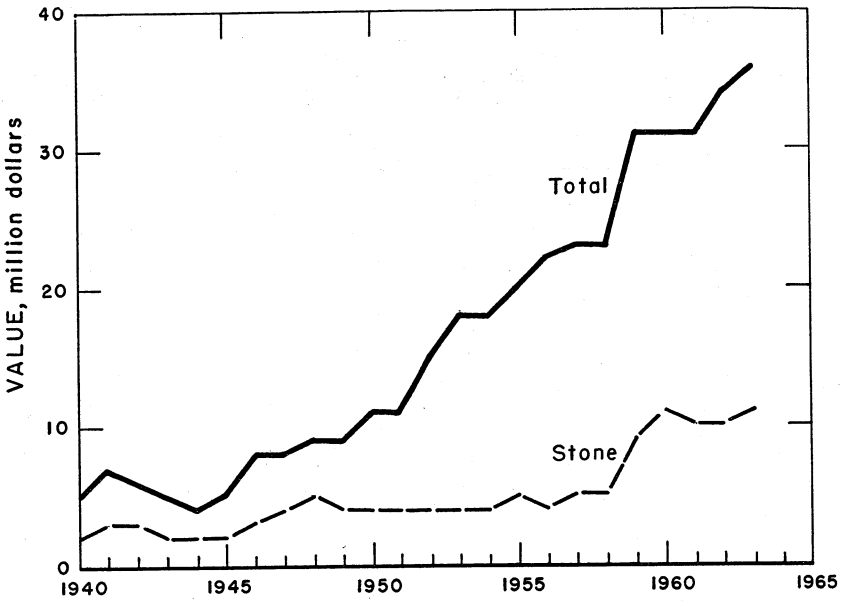


FIGURE 1.—Value of stone, and total value of mineral production in South Carolina, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$17,809	1958	$22,360
1953	20,955	1959	30,033
1954	20,106	1960	30,426
1955	22,793	1961	30,336
1956	20,917	1962	32,143
1957	22,513	1963	35,790

Trends and Developments.—Studies designed to help develop the State's mineral resources and improve geologic coverage were con-

tinued by the Division of Geology, State Development Board.[3] At yearend, reports of seven county investigations were in various stages of preparation, and geologic mapping of seven 7½-minute and four 15-minute quadrangles was in progress. Shorter investigations included mine and surface mapping in the Smyrna gold district in York County, power auger drilling of phosphorite sands in Jasper and Beaufort Counties, and sampling and laboratory testing of clay and shale from the Parksville area in McCormick County. Drilling in the Myrtle Beach and Wampee quadrangles resulted in the discovery of a large clay deposit in the vicinity of the Intracoastal Waterway between Myrtle Beach and Socastee. Short reports published by the Division[4] covered spectrochemical exploration near Donalds, occurrence of bismuth at the Brewer mine, Chesterfield County, and South Carolina bentonite as an extrusion aid.

E. I. du Pont de Nemours & Co., Inc. late in the year, received a 5-year extension of its contract to operate the Atomic Energy Commission (AEC) Savannah River plant near Aiken. The contract includes maintaining five production reactors, two chemical separation areas, the Savannah River Laboratory, and a plant for the extraction of heavy water, as well as operating supporting facilities. A number of peacetime projects in atomic energy are also covered by the contract, including projection of radioactive material for safe application and operation of the Heavy Water Components Test Reactor for testing fuel for nuclear power reactors.

The Southeast's first atomic powerplant, at Parr, 25 miles northwest of Columbia, began test operations. The Carolinas Virginia Nuclear Power Associates, Inc. (CVNPA), began studies in cooperation with AEC in 1958 and plant construction in 1960. The four power companies cooperating are Carolina Light & Power Co., Duke Power Co., South Carolina Electric & Gas Co., and Virginia Electric and Power Co. The 17,000-kilowatt plant was built as a prototype to develop and study economic ways of producing and utilizing nuclear power. The CVNPA reactor incorporates features different from any atomic powerplant now in commercial operation in the United States. The major difference between the Carolinas Virginia Tube Reactor and other pressure tube reactors built or being built is the use of a cold U-tube core design. The reactor core consists of 72 fuel assemblies contained in 36 pressure tubes which are suspended in a moderator tank. Fuel for the reactor is slightly enriched uranium dioxide, and heavy water is used as both the coolant and the moderator; AEC will supply both the fuel and the heavy water. Cost of the project exceeds $45 million, with AEC funds accounting for almost $13 million of the total. The Parr plant is reported to be the only plant in the world where electric power is generated by the three major energy sources now in use—water, coal, and uranium.

Electric power gains in new construction projects were noted by South Carolina Electric & Gas Co., major supplier in the State. The company also announced that in 1964 it would acquire the Neals Shoals hydroplant on the Brood River near Union and would improve the

[3] Johnson, H. S., Jr. Geologic Activities in South Carolina. Geologic Notes. Division of Geology, State Development Board, v. 8, Nos. 1–2, January-April 1964, 6 pp.
[4] Johnson, H. S., Jr. Geologic Notes. Division of Geology, State Development Board, v. 7, Nos. 1–6, January-December 1963.

Stevens Creek hydroplant on the Savannah River. A third generating unit of the company's Canadys Steam plant near Walterboro is in the planning stage. The Rural Electrification Administration announced about midyear that a $32 million Federal loan had been approved for the construction of a steam-generating plant near Conway, adjacent to the Myrtle Beach Expressway and alongside the Waccamaw River.

The South Carolina Ports Authority announced that tonnage handled at major ports was slightly under that of the peak year, 1962, when the ports handled 1,074,367 tons of cargo on 1,374 ships. Improvements continue to be made on deepwater ports, and at least four major ports projects have been slated for 1964.

South Carolina's Interstate Highway program continued to grow during the year but not as rapidly as in previous years. By November 1, about 300 miles of Interstate Highways were completed, 89 miles were under construction, 202 miles were in the survey or planning stage, and the remaining 89 miles were undergoing preliminary studies. Between the beginning of the postwar period until late 1963, the Federal Government had spent $635 million for all kinds of highway construction in the State, including $97 million for the Interstate Highway System. A major bridge project was begun near Georgetown; the Waccamaw River bridge when completed will have a length of 2,762 feet and a height of 65 feet, and is estimated to cost $2.6 million.

Legislation and Government Programs.—The South Carolina Water Pollution Control Authority within the State Health Department continued its program of monitoring the waters of the State in regions of major nuclear activity, its stream studies and classification, and its pollution abatement work. Under provision of the South Carolina Water Pollution Control Law of 1950 the Authority is required to have plans for all structures intended to discharge wastes to the waters of this State submitted for approval prior to construction. The Water Policy Commission of the Authority did not report legislative progress in its study leading to the development of an overall water policy law for the State.

Water.—The Bureau of Mines conducted a water canvass of the entire mineral industry of the United States for 1962. The results of that canvass for South Carolina are shown in table 3. Total water use was 5.8 billion gallons; 67 percent was new water, and the remainder was recirculated water. Quarries and mills used 26 percent of the new water and 47 percent of the recirculated water. Nonmetal mines and mills used 14 and 38 percent, and sand and gravel mines, requiring large amounts of water in their preparation plants, used 60 percent of the new water and 15 percent of the recirculated water.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Industry	New water	Recirculated water	Total water use
Quarries and mills	1,006	922	1,928
Nonmetal mines and mills	544	740	1,284
Sand and gravel mines	2,338	293	2,631
Total	3,888	1,955	5,843

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—Industrial Minerals, Inc., Cherokee County, the only barite producer in the State, decreased output slightly below that of 1962. The crude barite was ground for use as a rubber filler and shipped out of the State.

Cement.—Carolina Giant Division of Giant Portland Cement Co., near Harleyville, Dorchester County, remained the only cement producer in the State. By value, cement was the second leading mineral commodity in the State, exceeded by stone. Masonry cement, continuing its record growth, established an alltime high by increasing output 21 percent and value 17 percent over that of 1962. Portland cement output increased, 3 percent but value decreased slightly below that of 1962. Limestone and miscellaneous clay were mined in the State for use in manufacturing cement. Shipments of the finished products were made within the State and to surrounding marketing areas in nearby States.

Clays.—Clay, as in 1962, was the third leading commodity in the State in value, and accounted for 21 percent of the total mineral production value. Total clay output decreased 2 percent, after establishing a record high in 1962, but increased 6 percent in value over the previous year. In kaolin output, South Carolina continued to rank second only to Georgia. Kaolin production decreased 8 percent in tonnage but increased 5 percent in value; total output was 485,000 tons valued at $6.6 million. Exports of kaolin totaled 36,000 tons. Kaolin was produced at 14 mines by 9 companies in Aiken and Richland Counties, compared with 17 mines and 11 companies in 1962. Principal uses of kaolin were in refractories (firebrick and block), in fire clay mortar, as filler material in rubber, and in insecticides, fungicides, paint, fertilizer, plaster, and plaster products. J. M. Huber Corp., the largest kaolin producer in the State, operated three mines in Aiken County. Other kaolin producers, listed in order of descending rank, were Dixie Clay Co., National Kaolin Products Co., Southeastern Clay Co. (four mines), United Clay Mines Corp., Carolina Ceramics, Inc., Bell Kaolin Co., Columbia Pipe Co., and R. M. Stork Fire Brick Works.

Miscellaneous clay production increased 2 percent in tonnage and 9 percent in value over that of 1962, establishing a new record. Total output was 1,005,942 tons valued at $966,0000. Miscellaneous clay was used in the manufacture of cement, for heavy clay products such as building brick, paving brick, draintile, and sewer pipe, and in other products. Sixteen companies in 12 counties produced miscellaneous clay from 18 mines, accounting for increased output over that of 1962. Leading counties were Dorchester, Richland, and Marlboro. The leading producers of miscellaneous clay were Carolina Giant, Division of Giant Portland Cement Co. (Dorchester County), Columbia Brick & Tile Co. (Richland County), and Guignard Brick Co. (Lexington County).

Dorchester Ceramics, Inc., Summerville, completed construction of a new plant to manufacture face and common brick. The new plant

features a gas-fired horizontal kiln about 170 feet long, permitting continuous operation from raw clay to finished brick. The plant, estimated to cost $350,000, was developed by an Area Rehabilitation Administration (ARA) loan.

TABLE 4.—Kaolin sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Rubber	266,678	$3,590,158	$13.46	330,296	$4,690,269	$14.20
Insecticides and fungicides	24,041	297,289	12.37	24,398	310,911	12.74
Other refractories	20,000	96,800	4.84	(1)	(1)	(1)
Fire brick and block	48,400	290,084	5.99	10,868	93,988	8.65
Fertilizers	(1)	(1)	(1)	4,909	60,428	12.31
Saggers, pins, stilts, and wads	7,000	59,665	8.52	(1)	(1)	(1)
Architectural terra cotta	2,840	13,973	4.92	3,420	51,300	15.00
Heavy clay products	10,000	48,400	4.84			
Other uses [2]	149,034	1,882,762	12.63	110,866	1,415,860	12.77
Total	527,993	6,279,131	11.89	484,757	6,622,756	13.66

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes whiteware, foundries and steelworks, paper filling, linoleum and oilcloth, paint, plaster and plaster products, other fillers, exports, other uses and uses indicated by footnote 1.

Feldspar.—Spartan Minerals Co., Pacolet, produced feldspar from granite screenings obtained from the Campbell Limestone Co.'s Pacolet quarry. Quantity and value increased considerably over those of 1962. The material was ground and shipped out of the State for use by the ceramic industry.

Gem Stones.—Several collectors obtained small quantities of mineral specimens and gem stones. Total estimated value of the material was under $1,000 but showed an increase over that of 1962, when only one collector reported.

Kyanite.—Commercialores, Inc., Henry Knob mine, York County, the only producer in the State, set an alltime high in kyanite production. Tonnage increased 18 percent and value 14 percent over those of 1962, the previous record year. The material, after processing, was shipped to refractory manufacturers.

Mica.—Scrap mica output decreased 21 percent and value decreased 26 percent, compared with slight increases in 1962. Mineral Mining Corp., Kershaw, the only scrap producer in the State, continued recovery of scrap mica from an opencut mica schist deposit in Lancaster County. The material was dry-ground and shipped for use by manufacturers of pipeline, enamel, paint, plastics, welding rods, and electrical products.

Pyrites.—Pyrite output increased 17 percent and value 18 percent over those of 1962, compared with a considerable decrease in 1961. Produced as a byproduct of milling kyanite by Commercialores, Inc., York County, the only pyrite producer in the State, the material was shipped for out-of-State consumption.

Sand and Gravel.—Sand and gravel output and value set another alltime high record for the State, exceeding the 1962 record year by 22

percent in tonnage and 29 percent in value. By value, sand and gravel was the fourth ranking commodity, for the fourth consecutive year. Combined sand and gravel production was 4.1 million tons valued at $4.7 million, compared with 3.3 million tons valued at $3.7 million in 1962. During 1963, 28 operators in 17 counties produced commercial sand and/or gravel at 33 mines; 27 plants were stationary, and the remainder were portable. Government-and-contractor sand was produced in 10 counties by the State highway department and used for paving and road maintenance. Sixty-five percent of the material was sand, and the remaining 35 percent was gravel; all of the material was commercial except the 27,000 tons of Government-and-contractor sand. Fifty-seven percent of the total sand and gravel was transported by truck and the remaining 43 percent by rail; 80 percent of the material was processed and the remainder was unprocessed. Leading counties, in order of tonnage produced, were Marlboro, Lexington, Sumter, Chesterfield, and Dorchester. These five counties accounted for 77 percent of the total commercial sand and gravel output of the State. Leading individual producers, listed in order of output, were Becker County Sand & Gravel Co., with operations in Marlboro, Sumter, Chesterfield, and Dorchester Counties, Columbia Silica Sand Co., and Capital Sand Co., both of Lexington County. Construction sand was used for building, paving, railroad ballast, fill sand, and other purposes. Industrial sand was used for glass (melting only), molding, blast, fire, furnace, engine, filtration, and other uses. Ground sand was used for glass, filler, pottery, and other purposes. Construction gravel was used for building, paving, railroad ballast, and other purposes.

Carolina Sand Co., Aiken County, a new sand producer, reported for the first year. The company operated two mines, one at Aiken and one at Augusta.

TABLE 5.—Sand and gravel sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Aiken	(1)	(1)	268,080	$226,633
Anderson	6,695	$2,276	8,265	4,215
Chester	616	246		
Chesterfield	253,596	253,261	452,514	531,748
Greenville	70,728	35,015	50,472	30,513
Greenwood			55,000	65,000
Lancaster	2,005	501	2,068	1,055
Lexington	693,267	573,440	827,578	886,350
Marion	4,200	4,200	5,045	5,045
Oconee	6,426	2,180	3,454	1,762
Richland	221,144	93,079	95,109	43,331
Spartanburg	1,689	844	91,792	84,265
Union	150	112	200	100
York	1,667	567	1,500	765
Undistributed [2]	2,055,973	2,704,303	2,190,231	2,869,205
Total	3,318,156	3,670,024	4,051,308	4,749,987

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[2] Includes the following counties for which figures are withheld to avoid disclosing individual company confidential data: Aiken (1962), Charleston, Cherokee, Dorchester, Florence, Horry, Jasper, Kershaw, Marlboro, and Sumter.

TABLE 6.—Sand and gravel sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	1,336,423	$724,732	$0.54	1,888,347	$1,201,744	$0.64
Paving	325,583	130,129	.40	375,187	156,145	.42
Engine	24,366	73,646	3.02	29,513	95,380	3.23
Fill	104,610	42,541	.41	16,429	8,011	.49
Other uses [1]	296,071	740,380	2.50	311,774	994,269	3.19
Total	2,087,053	1,711,428	.82	2,621,250	2,455,549	.94
Gravel:						
Fill	(2)	(2)	(2)	1,066	740	.69
Other uses	(2)	(2)	(2)	[3] 1,428,992	[3] 2,293,698	[3] 1.61
Total	[4] 1,231,103	[4] 1,958,596	[4] 1.59	1,430,058	2,294,438	1.60
Total sand and gravel	3,318,156	3,670,024	1.11	4,051,308	4,749,987	1.17

[1] Includes railroad ballast, glass, molding, blast, fire or furnace filtration, and other sands.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Total gravel."
[3] Includes structural, paving, railroad ballast, and other gravel.
[4] Includes fill and other gravel.

Stone.—Stone, after dropping to the second ranking commodity by value in 1962, regained its position as the first ranking commodity in the State. Total stone, including crushed and dimension granite and crushed limestone, was 7.3 million tons valued at $10.9 million, increases of 14 percent in tonnage and 9 percent in value over the 1962 figures. Crushed granite showed the largest gain in stone output, with increases of 14 percent in tonnage and 9 percent in value. Dimension granite continued to decrease but not at the same rate as in 1962; tonnage decreased 2 percent and value 24 percent from those of 1962. Crushed limestone, which decreased in 1962, showed substantial increases of 17 percent in output and 20 percent in value. Crushed sandstone, previously reported under stone, was reclassified and all production is shown under feldspar.

Crushed granite was produced from 10 quarries by 5 companies in 9 counties, compared with the same number of quarries and companies operating in 8 counties in 1962. Output totaled 5.9 million tons valued at $8.8 million. Leading counties were Pickens, Lexington, and Greenville. These three counties accounted for 50 percent of the total output. Leading individual producing quarries listed in order of output were Campbell Limestone Co., Pickens County, Weston & Brooker Co., Lexington County, and Campbell Limestone Co., Greenville County. Palmetto Quarries Co. operated quarries in four counties and Campbell Limestone Co. in three counties. Eighty-seven percent of the granite was used for concrete, road metal, and screenings, 5 percent for railroad ballast, 2 percent for riprap, and 6 percent for other purposes, which included stone sand, poultry grit, and fill. Trucks transported 74 percent of the crushed granite, slightly more than in 1962, and railroads transported 26 percent.

Dimension granite, showing a slight decrease in output from that of 1962, was produced from five quarries by three companies in two counties. Winnsboro Granite Co., the leading producer of rough

granite for monument use, operated one quarry in Fairfield County. Kershaw Granite Co. and Comolli Granite Co. both operated two quarries in Kershaw County, producing rough stone for the same use.

Crushed limestone was produced from three quarries by three companies in Cherokee and Dorchester Counties. Campbell Limestone Co., the leading producer of crushed limestone in the State, operated a quarry in Cherokee County. Carolina Giant Division of Giant Portland Cement Co., near Harleyville, produced limestone for use in the manufacture of cement. Ideal Cement Co., also of Harleyville, with properties adjacent to Carolina Giant, produced crushed limestone for concrete, roadstone and screenings, and agricultural purposes. Ninety-two percent of the total crushed limestone was transported by truck and the remainder by railroad.

TABLE 7.—Crushed granite sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roadstone	4,274,360	$6,432,015	$1.50	5,126,446	$7,511,792	$1.47
Railroad ballast	329,702	411,500	1.25	284,322	359,135	1.26
Riprap	(1)	(1)	(1)	85,771	96,061	1.12
Other uses [2]	556,971	982,304	1.76	381,547	813,351	2.13
Total	5,161,033	7,825,819	1.52	5,878,086	8,780,339	1.49

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes stone sand, poultry grit, fill, and uses indicated by footnote 1.

Vermiculite.—By value, vermiculite was the fifth leading commodity in South Carolina, and for the fifth consecutive year the State ranked second to Montana in the Nation. Output increased 7 percent and value 3 percent, halting a decline experienced during 1961 and 1962. Zonolite Division of W. R. Grace & Co., the leading producer in the State, mined crude ore in Laurens County, processed the material at its Kearney plant, and shipped the processed ore to its own exfoliating plant near Travelers Rest. In addition, Zonolite shipped processed ore to many out-of-State exfoliating plants. Patterson Vermiculite Co., second leading producer in the State, closed its Union County operations near Cross Keys and returned to its Laurens County properties near Enoree for mining, processing, and exfoliating. American Vermiculite Co. closed its Propst mine and started producing from a new mine in Laurens County. Crude ore was mined at the Courtney, operating for the first year, and the Donnon mine, both in Laurens County. American exfoliated vermiculite at its own plant in the Enoree area. Total exfoliated vermiculite sold during the year increased 58 percent in tonnage and 55 percent in value from that of 1962.

METALS

Ferroalloys.—Virginia-Carolina Chemical Corp., near Charleston, Charleston County, produced ferrophosphorus as a byproduct of ele-

mental phosphorus furnace operations. Pittsburgh Metallurgical Co. Inc., also of Charleston, operated an electric-arc furnace and produced ferrosilicon, ferrochromium, and ferrochromium silicon. Pittsburgh announced late in the year that an expansion was planned for its Charleston facility, for its Calvert City, Ky., plant, and for its Niagara Falls, N.Y., operations.

Zirconium.—Orefraction Minerals, Inc., located near Andrews, Georgetown County, a subsidiary of M & T Chemicals, Inc., New York, continued operating its zircon processing plant. The company, now in its 48th year of operation, supplies dry-milled and granular zircon for the foundry, refractory, ceramic, and glass industries.

MINERAL FUELS

Peat.—Peat production in South Carolina continued to grow; tonnage rose 22 percent and value 25 percent above the 1962 levels. Ti-Ti Peat Humus Co. Inc., Colleton County, the only known producer in the State, produced reed-sedge peat for use as a soil conditioner.

REVIEW BY COUNTIES

Mineral production was recorded in 30 of the 46 counties, 2 counties more than in 1962. Dorchester, Aiken, and Lexington, the three leading counties in the State, furnished 57 percent of the total mineral production value. The leading 10 counties all had output exceeding $1 million and furnished 82 percent of the total, compared with 86 percent in 1962; the other 7 leading counties, listed in order of output, were Pickens, Fairfield, Marlboro, Richland, Spartanburg, Laurens, and Cherokee. Sixteen counties reported no mineral production. Sand and gravel was produced in 22 counties, miscellaneous clay in 12, gem stones in 11, granite in 10, kaolin in 2, and limestone in 2. Cement, vermiculite, feldspar, kyanite, barite, peat, and pyrites were produced in one county each.

Abbeville.—Mineral production was reported for the first year from this county. Six collectors of gem and mineral specimens collected silicate minerals, principally quartz and beryl, from different localities in the area. Jack Beal, Mountain Rest, Betty Boylston, E. L. Cox, N. A. McKeithan, Dr. J. Dan Williams, Greenville, and W. J. Martin, Greer, reported small amounts of gem materials.

Aiken.—For the eighth consecutive year Aiken ranked second by value in mineral production, exceeded only by Dorchester County. Commodities produced were kaolin, and sand and gravel. Kaolin was produced by 11 mines; 6 of the mines showed appreciable increases in output over that of 1962. The leading kaolin producer in the State, J. M. Huber Corp., operated 3 mines (Ideal, Barden, and Paragon mines). Other producers, listed in order of output, were Dixie Clay Co. (McNamee mine), National Kaolin Products Co. (Aiken County mine), United Clay Mines Corp. (No. 7 mine), Southeastern Clay Co. (Johnson, Rodgers, Toole, and Gardner mines), and Bell Kaolin Co. (Batesburg mine). Kaolin was used for whiteware, art pottery, firebrick and block, saggers, pins, stilts and wads, and other refractories. It was also used in paper filling and coating, rubber, linoleum, oilcloth,

TABLE 8.—Value of mineral production in South Carolina, by counties[1]

County	1962	1963	Minerals produced in 1963 in order of value
Abbeville		$95	Gem stones.
Aiken	(2)	6,604,569	Kaolin, sand and gravel.
Anderson	(2)	(2)	Granite, sand and gravel, gem stones.
Charleston	(2)	(2)	Sand and gravel.
Cherokee	$872,996	1,101,075	Limestone, sand and gravel, miscellaneous clay, barite gem stones.
Chester	246	(2)	Granite.
Chesterfield	253,261	531,748	Sand and gravel.
Colleton	(2)	(2)	Peat.
Dorchester	(2)	(2)	Cement, limestone, miscellaneous clay, sand and gravel.
Edgefield	10,096	22,210	Miscellaneous clay, gem stones.
Fairfield	(2)	(2)	Granite, miscellaneous clay.
Florence	(2)	(2)	Sand and gravel.
Greenville	(2)	(2)	Granite, sand and gravel, gem stones.
Greenwood	(2)	(2)	Granite, miscellaneous clay, sand and gravel, gem stones.
Horry	(2)	(2)	Sand and gravel.
Jasper	(2)	(2)	Do.
Kershaw	(2)	(2)	Sand and gravel, granite, miscellaneous clay.
Lancaster	(2)	(2)	Mica, miscellaneous clay, sand and gravel, gem stones.
Laurens	(2)	(2)	Vermiculite, gem stones.
Lexington	(2)	(2)	Granite, sand and gravel, miscellaneous clay.
Marion	(2)	(2)	Miscellaneous clay, sand and gravel.
Marlboro	(2)	(2)	Sand and gravel, miscellaneous clay.
Newberry		10	Gem stones.
Oconee	2,180	1,762	Sand and gravel.
Pickens	(2)	(2)	Granite.
Richland	(2)	(2)	Granite, kaolin, miscellaneous clay, sand and gravel.
Spartanburg	1,334,152	(2)	Granite, feldspar, sand and gravel, gem stones.
Sumter	(2)	(2)	Sand and gravel, miscellaneous clay.
Union	(2)	100	Sand and gravel.
York	(2)	(2)	Kyanite, pyrites, sand and gravel, gem stones.
Undistributed	31,428,069	28,217,431	
Total	33,901,000	36,479,000	

[1] The following counties are not listed because no production was reported: Allendale, Bamberg, Barnwell, Beaufort, Berkeley, Calhoun, Clarendon, Darlington, Dillon, Georgetown, Hampton, Lee, McCormick, Orangeburg, Saluda, and Williamsburg.

[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

paint, fertilizers, insecticides, fungicides, plaster and plaster products, other fillers, chemicals, exports, and miscellaneous applications.

Sand and gravel output increased over that of 1962 owing to production of two new sand mines. Sand and gravel producers, listed in order of output, were Perry Minerals Co. Inc. (Marine Minerals mine), Carolina Sand Co. (Aiken mine), a new operation, Augusta Sand & Gravel Co. (Clearwater mine), and Speer Sand & Gravel Co. (North Augusta mine), also new in 1963. Most of the sand and gravel was used for building and paving. Transportation was principally by truck with a small percentage by railroad.

Anderson.—Interstate Materials Co. (Anderson quarry) crushed granite for concrete, roadstone, and riprap. Output and value showed substantial increases over those of 1962. The State highway department mined 8,200 tons of sand valued at $4,200 for use in its road maintenance program. L. Rex Boone, Charlotte, N.C., collected corundum mineral specimens and reported for the first year.

Charleston.—Sandrying Co. (North Charleston mine) produced sand for use as fertilizer filler. West Virginia Pulp and Paper Co. (Charleston limekiln) produced industrial quicklime for use in the manufacture of pulp and paper. This was the second year that regenerated lime output has been reported. Virginia-Carolina Chemical Corp. and

Pittsburgh Metallurgical Co., Inc., both near Charleston, produced ferroalloys from electric furnace operations.

Cherokee.—By value, Cherokee County ranked 10th in mineral production, after dropping from the leading 10 counties in 1962. Campbell Limestone Co. (Blackburg quarry) led the county in mineral production, increasing output and value of crushed limestone substantially over those of 1962. Jobe Sand Co. (Blacksburg mine) produced industrial sand, and the State highway department mined a small amount of paving sand. Industrial Minerals, Inc. (Kings Creek mine), the only barite producer in the State, mined barite. Tonnage and value decreased from those of 1962. Broad River Brick Co. (Broad River mine) produced miscellaneous clay for heavy clay products. Bennett Brick & Tile Co. did not report. E. L. Cox, Greenville, W. J. Martin, Greer, and N. A. McKeithan and Charles R. Wuest, Taylors, collected gem and mineral specimens and reported for the first year.

Chester.—Palmetto Quarries Co. (Chester quarry) opened up a new quarry in this county and reported crushed granite production for the first time. The material was used primarily for concrete and roadstone.

Chesterfield.—Three commercial sand and/or gravel producers and one Government-and-contractor sand producer reported output, compared with four reporting commercial producers in 1962. Becker County Sand & Gravel Co., the leading producer in the county, and the State, mined sand and gravel from its Cash mine. Other producers, listed in order of output, were F. T. Williams Co. (Pageland mine), Charlotte Sand Co. (Mount Crogan mine), and the State highway department. Most of the material was used for building and paving purposes and was transported primarily by truck.

Colleton.—The only known mineral producer in this county was Ti-Ti Peat Humus Co. Inc., near Green Pond, who produced peat. Quantity and value showed a substantial increase over those of 1962, also a good year. The material was used primarily for soil conditioning purposes.

Dorchester.—Dorchester County, by value, led the State in mineral production for the eighth consecutive year. Cement, clay, and limestone used in the manufacture of cement, clay for heavy clay products, and sand and gravel production accounted for the mineral importance of the county. Carolina Giant, Harleyville, produced masonry and portland cement and mined crushed limestone and clay for use in cement manufacture. Ideal Cement Co. (Carolina quarry) produced crushed limestone for use in concrete and roadstone and for agricultural purposes. Becker County Sand & Gravel Co. (Summerville mine) started a new sand operation in the county. Murray Mines Co. (Murray mine) and Bailey's Sand Pit produced building sand. Deerfield Sand & Mining Co. did not report operation of its mine this year. Salisbury Brick Corp. (Salisbury mine) and Dorchester Ceramics, Inc., a new clay operation, produced miscellaneous clay for use in making brick. The new plant of Dorchester Ceramics estimated to cost $350,000, featured a gas-fired horizontal kiln about 170 feet long, permitting continuous operation from raw clay to finished brick.

Edgefield.—Merry Bros. Brick & Tile Co. produced miscellaneous clay for heavy clay products. Output and value increased substantially over those of 1962. N. A. McKeithan, Greenville, collected mineral specimens of pyrite and reported for the first year.

Fairfield.—The county dropped from third place in 1962 to fifth place in value of mineral production. Rion Crushed Stone Corp. (Rion quarry) led the county in mineral production. The company's crushed granite output increased slightly over that of 1962. Palmetto Quarries Co. (Blair quarry) produced crushed granite for concrete, roadstone, railroad ballast, and stone sand. Winnsboro Granite Co. (Winnsboro quarry) quarried rough dimension granite for the monumental and architectural stone industries. Richland Shale Products Co. (Richtex mine) and Carolina Ceramics, Inc. (Fairfield mine), mined clay and shale for use in heavy clay products.

Florence.—Coastal Sand Co. (Johnsonville mine) and Lanford Sand Co. (Florence mine) produced sand for building, paving, and fill. Output and value decreased from those of 1962. All of the sand was transported by truck.

Georgetown.—International Paper Co. (Georgetown limekiln) produced regenerated quicklime for use in the manufacture of pulp and paper. Output and value of this secondary product increased over those of 1962.

Greenville.—For the first year, Greenville County dropped from the 10 leading counties in value of mineral production. Campbell Limestone Co. (Lakeside quarry) crushed granite for concrete, roadstone, and railroad ballast. W. M. Barber Sand Co. (Greenville mine), Zupan Sand Co. (Greenville mine), Cooper Sand Co. (Piedmont mine), a new producer reporting for the first year, and Saluda Sand Co. (Garrison mine) produced building sand. Combined output and value decreased from that of 1962. Government-and-contractor sand for use in road maintenance was produced by the State highway department. E. L. Cox, N. A. McKeithan, and Dr. J. Dan Williams, all of Greenville, and Charles R. Wuest, Taylors, collected gem or mineral specimens in the county and reported for the first year.

Greenwood.—Palmetto Quarries Co. (Stoney Point quarry) led the county in mineral production. Crushed granite output and value decreased from those of 1962. Southern Brick Co. (Ninety-Six mine) and Angus Brick & Tile Co. (Ninety-Six mine) mined miscellaneous clay for use in making brick, tile, and other heavy clay products. Perry Minerals Co. Inc. (Ware Shoals mine), reporting for the first year, mined building sand. E. L. Cox, Greenville, Mrs. Walker Ledford, Waterloo, W. J. Martin, Greer, and N. A. McKeithan, Greenville, collected quartz crystals and other mineral specimens and reported for the first year.

Horry.—E. P. Pitts Sand Corp. (Pitts mine) produced sand for industrial uses, principally for glass manufacture, and shipped all the material by railroad. Output and value increased over those of 1962.

Jasper.—Deerfield Sand & Mining Co. (Deerfield mine), Ridgeland, produced building and paving sand for local consumption. Output and value increased over those of 1962.

Kershaw.—Comolli Granite Co. (Carolina Diamond Grey and Carolina Mahogany quarries) and Kershaw Granite Co. (Kershaw and Coral Gray quarries) quarried rough dimension granite for monumental and architectural stone uses. Combined output and value increased considerably over that of 1962. Comolli operated the Carolina Mahogany quarry for the first year. Whitehead Bros. Co. (Lugoff mine) produced industrial sand, and Kershaw County Sand Co. (Camden mine) mined sand for building and fill purposes. Carolina Ceramics, Inc. (Kershaw mine), produced miscellaneous clay and shale for heavy clay products. Mineral Mining Corp. (Kershaw grinding plant) ground mica from mica schist deposits in Lancaster County.

Lancaster.—Mineral Mining Corp. (Kershaw Strip mine) recovered scrap mica from a mica schist deposit and for the second year was the only mica producer in the State. Ashe Brick Co. (Van Wyck mine) mined miscellaneous clay for heavy clay products. Output and value remained about the same as in 1962. The State highway department mined sand for use in its road maintenance program. Robert Fulton, Washington, Ill., collected pyrite specimens from the Haile gold mine and reported for the first year.

Laurens.—Vermiculite was the major mineral mined in this county; it was mined, processed, and exfoliated in the Enoree area. Zonolite Division of W. R. Grace & Co. was the leading producer and processor in the area. The company shipped processed ore for exfoliating to Travelers Rest and to out-of-State plants. Patterson Vermiculite Co. (Laurens County mine) closed its Union County mine after 1 year of operation and moved back to the Enoree area. The company mined crude ore adjacent to its exfoliating plant. American Vermiculite closed its Propst mine and opened a new mine, the Courtney. The company also operated the Donnon mine and exfoliated material from both mines at its Enoree plant. Total crude vermiculite output increased 6 percent over that of 1962. N.A. McKeithan, Greenville, collected rutile specimens and reported for the first year.

Lexington County.—Lexington County, ranking fourth in mineral production value in 1962, moved to third place, indicating continued growth of the mineral industries. Weston & Brooker (Cayce quarry), leading producer in the county, crushed granite for concrete, roadstone, and other uses. Output and value increased considerably over those of 1962. Pennsylvania Glass Sand Corp. (Columbia mine), in its second year of operation, more than doubled output and value over those of 1962. The company produces industrial sand for a variety of uses. Columbia Silica Sand Co. (Edmund mine) increased its output of industrial sand. Capital Sand Co. (Capital mine) mined paving sand and increased its output slightly. Foster Bros. Dixiana Sand Co. (Dixiana mine) mined sand for building and industrial uses. Strickland Sand Co. (Strickland mine) mined paving sand and reported for the first year from this site. The State highway department also mined a small amount of paving sand for use in road maintenance. Guignard Brick Co. (Columbia mine) mined miscellaneous clay for use in manufacturing brick. Output and value were about the same as in 1962.

Marion.—J. D. Murchison (Pee Dee mine) produced miscellaneous clay for use in manufacturing building brick. Output and value increased over those of 1962. Sandy Bluff Sand Co. (Snipes mine), Mullins, increased output of building sand. All of the sand was transported by truck.

Marlboro.—Marlboro County retained its sixth place rank in value of mineral production. The county also continued to rank first in sand and gravel production. Becker County Sand & Gravel Co. (Marlboro mine) mined building and paving sand and gravel, and gravel for other uses. Output and value remained about the same as in 1962. Palmetto Brick Co. (Irby mine) and Cheraw Brick Works, Inc. (Cheraw mine) produced miscellaneous clay for manufacturing building brick. Output and value of the combined mines increased slightly over those of 1962.

Newberry.—N. A. McKeithan, Greenville, collected mineral specimens of kyanite crystals from the Little Mountain Area of the county.

Oconee.—The State highway department mined sand for use in its road maintenance program. Output and value decreased considerably from those of 1962.

Pickens.—Pickens County moved up from the seventh to the fourth ranking county in value of mineral production. Campbell Limestone Co. (Beverly quarry) continued to increase its crushed granite output and was the leading crushed granite operation in the State. The material was used principally for concrete, roadstone, riprap, and fill.

Richland.—Richland County dropped from the fifth to seventh ranking county in 1963. The county continued to be an important granite, kaolin, and miscellaneous clay producing area of the State. Palmetto Quarries Co. (Columbia quarry) crushed granite for concrete, roadstone, and other uses. Output and value showed substantial increases over those of 1962. Kaolin for refractory purposes was mined by Carolina Ceramics, Inc. (Pontiac mine), Columbia Pipe Co. (Ridgewood mine), and R. M. Stork Firebrick Works (Stork mine). Miscellaneous clay and shale was mined by Columbia Brick & Tile Co. (Columbia mine) and Carolina Ceramics, Inc. (Richland mine). Harrison Sand Corp. (Harrison mine) produced building and industrial sand. Output and value increased over those of 1962.

Spartanburg.—Spartanburg County dropped from seventh to eighth place in value of mineral production. Campbell Limestone Co. (Pacolet and Pelham quarries) crushed granite principally for concrete and roadstone. Output and value increased slightly over that of 1962. Campbell was the leading mineral producer in the county. Spartan Minerals Co. (Pacolet mine) produced crude and ground feldspar from granite screenings from Campbell Limestone Co.'s Pacolet quarry. The material was reclassified, excluding a silica product for the first year, and increased feldspar production considerably. The material was used locally and shipped out of the State for use in ceramics and glass, and for other uses. L. G. Chapman Sand Pit, Inc., reporting for the first year, produced building sand, fill sand, and fill gravel. The State highway department mined sand for use in its road maintenance program. E. L. Cox, Greenville, collected corundum mineral specimens from the Pacolet area. Zonolite Division of

W. R. Grace & Co. operated an exfoliating plant at Travelers Rest, using processed vermiculite ore from its nearby Enoree operation.

Sumter.—For the fourth consecutive year, the county ranked third in sand and gravel production. Becker County Sand & Gravel Co. (Camden mine) mined sand for building, paving, and railroad ballast uses and gravel for construction purposes. Output and value increased over those of 1962. Eastern Brick & Tile Co. (Wedgefield mine), in its third year of production, mined miscellaneous clay for use in heavy clay products. Output and value were about the same as in 1962.

Union.—Patterson Vermiculite Co. closed its mine near Cross Keys and returned to its Enoree area operation. The State highway department mined a small quantity of sand for use in its road maintenance program.

York.—Commercialores, Inc. (Henry Knob mine), mined kyanite and recovered pyrite as a byproduct of kyanite milling operations. The kyanite was shipped for use in firebrick and tile, and for other purposes. Pyrite was shipped for out-of-State consumption. The State highway department mined sand for use in its highway maintenance program. Bowater-Carolina Corp. (Catawba limekiln) produced regenerated quicklime for the manufacture of pulp and paper. Bill Bibb, Charlotte, N.C., Joe Leonhardt, Gastonia, N.C., and Gary McCain, Pineville, N.C., collected mineral specimens of corundum and other minerals.

The Mineral Industry of South Dakota

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the South Dakota State Geological Survey for collecting information on all minerals except fuels.

By Carl L. Bieniewski [1] and Duncan J. McGregor [2]

MINERAL production in South Dakota for 1963 established a new record of $55.1 million, surpassing the previous record set in 1959 by $5.6 million. For the 15th consecutive year, the State led the Nation in gold production. Record outputs were reported for sand and gravel, lime, uranium ore, and vanadium.

TABLE 1.—Mineral production in South Dakota [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate—short tons, gross weight	144	$77	(2)	(2)
Cement—thousand 376-pound barrels	2,360	7,566	1,914	$6,107
Clays—thousand short tons	249	690	315	1,958
Coal (lignite)—do	18	77	16	62
Copper (recoverable content of ores, etc.)—short tons	----	----	1	(3)
Feldspar—long tons	29,697	191	25,590	157
Gem stones	(4)	20	(4)	20
Gold (recoverable content of ores, etc.)—troy ounces	577,232	20,203	576,726	20,185
Gypsum—thousand short tons	23	93	24	97
Iron ore (usable)—thousand long tons, gross weight	34	113	----	----
Lead (recoverable content of ores, etc.)—short tons	3	1	4	1
Mica:				
Scrap—do	210	6	(2)	(2)
Sheet—pounds	2,085	12	10,000	(3)
Petroleum (crude)—thousand 42-gallon barrels	169	(2)	[5] 187	(2)
Sand and gravel—thousand short tons	15,371	9,207	20,806	16,313
Silver (recoverable content of ores, etc.) thousand troy ounces	113	123	117	150
Stone—thousand short tons	2,852	6,533	2,794	7,339
Uranium ore—short tons	29,452	370	72,088	1,931
Value of items that cannot be disclosed: Lime, lithium minerals, vanadium, and values indicated by footnote 2	----	[6] 505	----	738
Total	----	[6] 45,787	----	55,058

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Less than $500.
[4] Weight not recorded.
[5] Preliminary figure.
[6] Revised figure.

[1] Mining engineer, Bureau of Mines, Denver, Colo.
[2] Director and State geologist, South Dakota State Geological Survey, Vermillion, S. Dak.

TABLE 2.—Mineral production in South Dakota, 1876–1963

Commodity	Earliest year of production	Quantity to date	Value (thousands)	Percent of grand total value
Metals:				
Beryllium concentrate—short tons	1914	4,964	$1,654	0.1
Columbium-tantalum concentrate—thousand pounds	1905	188	197	(1)
Copper (recoverable content of ores, etc.)—thousand pounds	1889	216	38	(1)
Gold (recoverable content of ores, etc.)—thousand troy ounces	1876	29,963	830,292	65.6
Iron ore (usable)—thousand long tons	1893	158	631	(1)
Lead (recoverable content of ores, etc.)—thousand pounds	1889	1,008	72	(1)
Manganese ore—short tons	1891	205	4	(1)
Silver (recoverable content of ores, etc.)—thousand troy ounces	1876	11,875	8,948	0.7
Tin (content of ores and concentrates)—thousand pounds	1884	380	110	(1)
Tungsten ore and concentrate (60 percent WO_3 basis)—short tons	1898	1,638	1,379	0.1
Uranium ore—thousand short tons	1952	453	7,053	0.6
Vanadium—short tons	1954	91	321	(1)
Zinc (recoverable content of ores, etc.)—thousand pounds	1889	530	56	(1)
Miscellaneous (antimony and arsenic)	(2)		10	(1)
Total value of metals production			850,765	67.2
Nonmetals:				
Cement—thousand 376-pound barrels	1891	36,695	90,959	7.2
Clays—thousand short tons	1888	6,621	39,294	3.1
Feldspar—thousand long tons	1923	1,387	6,705	0.5
Gem stones—weight not recorded	1906		231	(1)
Gypsum—thousand short tons	1884	559	2,552	0.2
Lithium minerals—do	1898	107	3,930	0.3
Lime—do	1896	216	2,219	0.2
Mica:				
Scrap—short tons	1899	51,775	1,006	0.1
Sheet—do	1879	3,535	3,074	0.2
Pumice—do	1904	1,880	18	(1)
Pyrites—long tons	1903	3,108	13	(1)
Sand and gravel—thousand short tons	1889	259,888	134,322	10.6
Stone—do	1889	46,091	124,465	9.8
Miscellaneous (asbestos, graphite, flint lining, and flint pebbles)	(3)		50	(1)
Total value of nonmetals production			408,838	32.3
Mineral fuels:				
Coal—thousand short tons	1895	1,356	3,208	0.3
Natural gas—million cubic feet	1899	1,183	102	(1)
Petroleum (crude)—thousand 42-gallon barrels	1954	[4] 1,232	[4] 2,720	0.2
Total value of mineral fuels production			6,030	0.5
Grand total value of mineral production			1,265,633	100.0

[1] Less than 0.1 percent.
[2] Earliest year of production for antimony, 1901; arsenic, 1924.
[3] Earliest year of production for asbestos, 1895; graphite, 1903; flint lining, 1925; flint pebbles, 1926.
[4] Includes preliminary figure for 1963.

TABLE 3.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$33,917	1958	$41,733
1953	35,157	1959	48,009
1954	38,970	1960	46,638
1955	41,387	1961	43,780
1956	41,836	1962	44,344
1957	40,241	1963	51,942

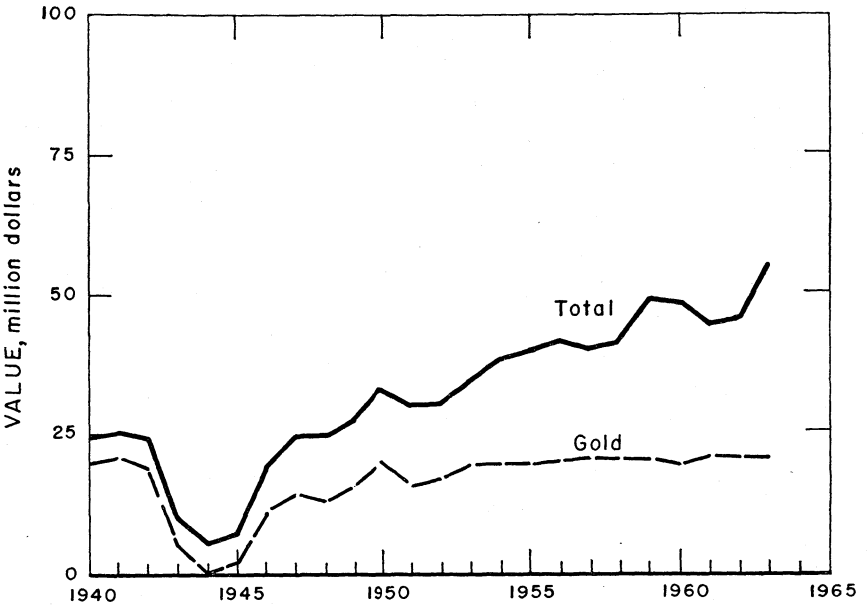


FIGURE 1.—Value of gold, and total value of mineral production in South Dakota, 1940–63.

The $55.1 million was 20 percent greater than the State total value of mineral production reported for 1962. Substantial increases in production of sand and gravel and uranium ore accounted for the significant rise in total value.

Of the 67 counties, only Jones and Washabaugh had no reported mineral production. Butte, Custer, Grant, Harding, Lawrence, Minnehaha, and Pennington Counties were the only counties with production valued over $1 million. The leading county was Lawrence, with $20.8 million, representing 38 percent of the State total value of mineral production.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Government Programs.—Construction projects financed by Federal, State, county, and municipal funds accounted for a large part of the production of cement, sand and gravel, and stone. These raw materials were used mostly in highway construction projects. Contracts for such projects totaled $60.4 million,[3] an increase of $25.9 million, or 75 percent over that of 1962. Slightly more than half of the money went for construction of roads in the interstate highway system. Of

[3] Engineering News-Record. State Highway Contracts will Rise. V. 172, No. 13, Mar. 26, 1964, pp. 13–15.

the 679 miles [4] designated for South Dakota in this system at yearend, 247 miles was open to traffic. Work (either in the construction, engineering, or right-of-way phase) was in progress for 389 miles, and only 43 miles had no work underway. During the year, heavy-construction work was completed on the missile complex centered around Ellsworth Air Force Base, Rapid City. Construction work continued throughout the year at the Big Bend Dam project near Fort Thompson. Closure of the 17-million-cubic-yard earth-fill dam took place in July.

The Pathfinder atomic powerplant, a cooperative venture of the U.S. Atomic Energy Commission (AEC) and Northern States Power Co., near Sioux Falls, was virtually completed at yearend. Initial criticality of the reactor was expected in early 1964, and power design operation of 58,500 net electrical kilowatts was expecetd by late 1964. The fuel for the reactor was expected to be slightly enriched uranium, and that for the superheater, highly enriched uranium.

The Federal Government made mineral payments to South Dakota totaling $116,731 which represented 37.5 percent of bonuses, royalties, and rentals from mineral leases on Federal lands within the State. Bonuses, royalties, and rentals paid to the State from mineral leases on State lands amounted to $236,540.

Water.—The Federal Bureau of Mines conducted a nationwide survey of water used during 1962 in the mineral industries. Table 4 presents data obtained for South Dakota.

TABLE 4.—Water used during 1962 in the mineral industry by type of operations

(Million gallons)

Type of operation [1]	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	3	----	3	3	----	0.52
Coal mines						
Metal mines and mills	3,302	1,050	4,352	2,666	636	158.05
Nonmetal mines and mills						
Sand and gravel operations	46	195	241	36	10	5.00
Total	3,351	1,245	4,596	2,705	646	----
Oil- and natural-gas-well drilling	----	----	1	----	----	----

[1] Water survey did not include cement plants, lime plants, metal smelters, metal refineries, petroleum refineries, natural-brine operations, sand and gravel operations using suction dredges without preparation plants, stockpile operations, and assessment work operations.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Cement shipments from the State-owned plant at Rapid City was 446,000 barrels or 19 percent less than that of 1962. Portland cement constituted 98 percent and masonry cement the remaining 2 percent. The average price for portland cement was $3.16 per barrel

[4] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1963. Press Release BPR 64–9, Feb. 7, 1964.

(376 pounds) which was 2 cents per barrel below that of 1962. The average price of masonry cement remained the same as in 1962, $3.30 per barrel (280 pounds).

Two-thirds of all cement shipments was consumed within the State. Portland cement was shipped to Colorado, Minnesota, Missouri, Montana, Nebraska, North Dakota, and Wyoming. Masonry cement was shipped to the same States except Colorado and Minnesota. Highway contractors constituted the largest percentage of customers, purchasing 28 percent of the shipments of portland cement; however, these shipments were about half of those made in 1962. Ready-mixed concrete companies received 26 percent of the portland-cement shipments, building-materials dealers 23.5 percent, concrete-product manufacturers 12 percent, contractors other than highway 10 percent, and Governmental agencies and other customers 0.5 percent. The cement plant was operated at 72 percent of its annual finished-cement (portland) capacity of 2.6 million barrels. Electrical energy needed to operate the plant was 37.3 million kilowatt-hours, compared with 46.5 million kilowatt-hours needed in 1962 when the plant was operated at 88 percent capacity.

Clays.—Clays increased 27 percent in quantity and nearly tripled in value over the output of 1962. Greater output of bentonite, which had a much higher value than other clays produced in the State, accounted for the increases. The main uses for bentonite were as a refractory material and as a rotary-drilling-mud agent. Miscellaneous clay was produced and used to make cement, heavy clay products, and lightweight aggregates. Bentonite was produced in Butte County, and miscellaneous clay was produced in Butte and Pennington Counties. American Colloid Co. was the only bentonite producer; and Black Hills Clay Products Co. Lightweight Aggregates, Inc. and the South Dakota Cement Commission were the only miscellaneous clay producers.

Feldspar.—Output of feldspar was 4,107 long tons or 14 percent below the quantity produced in 1962. About 75 percent of the production came from mines in Custer County; the balance came from mines in Pennington County. Production was obtained from 29 mines, compared with 49 mines in 1962. Four mines accounted for about 75 percent of the total output. The Shamrock and Tip Top mines operated by International Minerals and Chemical Corp. (IMC), the Peerless by Northwest Beryllium Co., and the White Elephant by Briggs Manufacturing Co. were the only mines having production of 1,000 long tons or more. IMC ground crude feldspar at its Custer plant. Most of the ground feldspar was shipped to eastern manufacturers of glass, porcelain, or pottery products.

Gem Stones.—Agate, andalusite, beryl, calcite, carnotite, chalcedony, feldspar, graphic granite, hematite, jasper, lepidolite, mica, quartz, rose quartz, schist, sillimanite, and unidentified mineral specimens were gathered by various collectors, rockshop dealers, and members of gem societies. Most of the specimens were found in Custer and Pennington Counties.

Gypsum.—Production of crude gypsum by the only producer, the South Dakota State Cement Commission, was 1,000 tons more than in 1962; however, less crude gypsum was used as a portland-cement

retarder at the cement plant than in 1962. Excess production was stockpiled at the plant.

Lime.—Output of lime increased 38 percent over that of 1962. More quicklime was produced and used at the Utah-Idaho Sugar Co. plant at Belle Fourche for making a record quantity of sugar from sugar beets. At Pringle, quicklime for metallurgical uses was produced by Black Hills Lime Co., the only other lime producer.

Lithium Minerals.—Hough & Judson produced lithium ore containing amblygonite from the Hugo mine at Keystone.

Mica.—The termination of the Government domestic mica purchasing program in June 1962 resulted in an adverse effect on the mica mining industry. Production of mica was reported for only two

TABLE 5.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	527	$510	598	$597
Paving	163	167	317	304
Railroad ballast			(1)	(1)
Fill	11	5	44	29
Industrial:				
Molding	(2)	(2)		
Blast	(2)	(2)		
Oil (hydrafrac)	(2)	(2)		
Other	18	58	3	2
Total	719	740	962	932
Gravel:				
Construction:				
Building	139	201	390	421
Paving	2,855	1,677	1,898	1,813
Railroad ballast	45	33	52	40
Fill	40	24	58	34
Other	12	8		
Miscellaneous	22	15	139	79
Total	3,113	1,958	2,537	2,387
Total sand and gravel	3,832	2,698	3,499	3,319
Government-and-contractor operations:				
Sand:				
Paving	662	509	1,352	1,294
Fill	10	9		
Total	672	518	1,352	1,294
Gravel:				
Building	95	85	9	9
Paving	10,165	5,515	15,944	11,689
Fill	607	391	2	2
Total	10,867	5,991	15,955	11,700
Total sand and gravel	11,539	6,509	17,307	12,994
All operations:				
Sand	1,391	1,258	2,314	2,226
Gravel	13,980	7,949	18,492	14,087
Total	15,371	9,207	20,806	16,313

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Fill."
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Other."

mines; in 1962 eight mines had some production. Sheet mica of the lowest grade (punch-and-washer quality) was produced by one operator from a mine in Custer County, and scrap mica by another operator from a mine in Pennington County.

Sand and Gravel.—Production of sand and gravel of 20.8 million tons established a new record output by surpassing the previous record of 1959 by 3 million tons. The 20.8 million tons was 5.4 million tons or 35 percent greater than that of 1962.

Nineteen and one-half million tons or 94 percent of the sand and gravel was used for paving (road construction, including maintenance). Increased road construction was reflected in the additional 5.7 million tons used for this type of work. Sand and gravel for building construction totaled 997,000 tons. The balance, about 300,000 tons, of the output was used for fill, industrial uses, miscellaneous construction, and railroad ballast. Government-and-contractor operations accounted for 17.3 million tons or 83 percent of the total output. The balance, 3.5 million tons or 17 percent of the total output, was produced at commercial operations.

Of the State 67 counties, only Jones and Washabaugh did not have any sand and gravel production. Last year Pennington County was the only county having production over 1 million tons. Because of more highway construction work this year, Minnehaha, Pennington and Turner Counties had a production of over 1 million tons.

TABLE 6.—Sand and gravel production in 1963, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Aurora	209	$145	Jackson	77	$69
Beadle	327	260	Jerauld	570	414
Bennett	19	13	Kingsbury	225	189
Bon Homme	191	178	Lake	294	242
Brookings	635	581	Lawrence	471	344
Brown	398	302	Lincoln	310	257
Brule	664	356	Lyman	555	417
Buffalo	282	166	Marshall	250	162
Butte	775	597	McCook	285	179
Campbell	22	17	McPherson	170	120
Charles Mix	133	92	Meade	489	481
Clark	140	118	Mellette	88	70
Clay	71	70	Miner	253	225
Codington	415	410	Minnehaha	1,827	1,268
Corson	522	319	Moody	340	234
Custer	486	610	Pennington	1,174	1,144
Davison	141	97	Perkins	261	180
Day	325	253	Potter	301	191
Deuel	130	106	Roberts	306	250
Dewey	74	46	Sanborn	50	39
Douglas	536	326	Shannon	8	5
Edmunds	106	70	Spink	235	205
Fall River	41	51	Stanley	44	34
Faulk	195	157	Sully	63	63
Grant	940	940	Todd	19	14
Gregory	176	124	Tripp	1	1
Haakon	370	284	Turner	1,631	939
Hamlin	134	134	Union	96	95
Hand	205	285	Walworth	407	303
Hanson	10	10	Yankton	136	134
Harding	282	188	Ziebach	66	37
Hughes	294	251			
Hutchinson	493	398	Total	20,806	16,313
Hyde	63	54			

Stone.—Stone decreased 58,000 tons or 2 percent in quantity and increased $806,000 or 12 percent in value, compared with 1962 production. A greater average price for crushed stone and an increase in quantity of dimension stone, which is higher priced than crushed stone, accounted for the increase in total stone value.

About 2 million tons of crushed stone was used as aggregate for making concrete and roads. Crushed stone was also used as riprap

TABLE 7.—Stone sold or used by producers, by kinds

Year	Granite		Limestone		Sandstone [1]	
	Short tons	Value	Short tons	Value	Short tons	Value
1959	18,568	$3,065,502	1,599,521	$2,331,485	914,800	$1,657,900
1960	17,915	3,002,488	1,578,618	2,501,216	1,031,524	1,855,179
1961	26,476	2,823,441	1,378,062	1,939,293	984,512	1,493,464
1962	25,923	2,442,181	1,572,300	2,184,374	1,119,655	1,779,639
1963	24,630	2,761,546	1,652,571	2,427,016	1,033,749	2,070,837

Year	Other stone		Total	
	Short tons	Value	Short tons	Value
1959	187,696	$187,696	2,720,585	$7,242,583
1960	520,945	550,469	3,149,002	7,909,352
1961	417,391	385,953	2,806,441	6,642,151
1962	[2] 134,056	[2] 126,373	2,851,934	6,532,567
1963	82,618	79,310	2,793,568	7,338,709

[1] Includes quartz and quartzite.
[2] Includes slate.

TABLE 8.—Stone sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction and rubble—short tons	(1)	(1)	(1)	(1)
Rough architectural—cubic feet	(1)	(1)	(1)	(1)
Dressed architectural—do	(1)	(1)	[2] 22,518	$167,714
Rough monumental—do	(1)	(1)	(1)	(1)
Dressed monumental—do	[3] 122,572	$1,644,297	[4] 170,511	2,482,407
Flagging—do	(1)	(1)	(1)	(1)
Other—do	[5] 93,925	800,634	[6] 71,900	134,652
Total (approximate, in short tons)	18,457	2,444,931	25,430	2,784,773
Crushed and broken stone:				
Riprap—short tons	313,753	404,891	184,140	238,984
Railroad ballast—do	183,280	234,302	(1)	(1)
Concrete and roadstone—do	1,693,440	2,479,787	1,929,070	3,325,693
Cement—do	593,557	890,335	416,642	624,963
Other—do	[7] 49,447	[7] 78,321	[8] 238,286	[8] 364,296
Total—do	2,833,477	4,087,636	2,768,138	4,553,936
Total stone (approximate, in short tons)	2,851,934	6,532,567	2,793,568	7,338,709

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Approximately 1,824 short tons.
[3] Approximately 9,926 short tons.
[4] Approximately 13,813 short tons.
[5] Approximately 8,531 short tons.
[6] Approximately 9,793 short tons.
[7] Includes stone used in filler, lime, and refractory.
[8] Includes stone used in asphalt, filler, lightweight aggregate, lime, and refractory.

and railroad ballast, for making cement and lime, and for some miscellaneous purposes. The average price of crushed stone was $1.65 per ton, an increase of $0.21 per ton over that of 1962. Most of the crushed stone was produced in Hanson, Minnehaha, and Pennington Counties. Crushed limestone and crushed sandstone, mostly quartzite, accounted for nearly 2.7 million tons or 96 percent of the stone output.

Dimension granite was the most valuable stone produced; the output value, nearly $2.8 million, represented 38 percent of the total value of all stone produced. Six companies operating quarries in Grant County produced the output of dimension granite. About three-fourths of the dimension granite produced at the quarries was made into dressed monumental stone. The balance was made into rough and dressed architectural blocks for use in buildings and rough blocks for making monuments. Dimension limestone used as flagging and rough construction stone was produced in Pennington County.

METALS

Beryllium.—Production of beryllium virtually ceased; only a small quantity of beryl was produced and sold from a single operation; 27 mines had production in 1962. The big reduction in output and in the number of mining operations was due to the loss of the principal market caused by the termination of the Government domestic beryl purchasing program in June 1962.

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1954–58 (average)	2	----------	1,722	555,759	$19,452	146	$132
1959	2	----------	1,778	577,730	20,221	124	113
1960	2	----------	1,767	554,771	19,417	108	98
1961	2	----------	1,781	557,855	19,525	127	118
1962	2	----------	1,869	577,232	20,203	113	123
1963	3	1	1,909	576,726	20,185	117	150
1876–1963	(3)	(3)	(3)	29,962,720	830,292	11,875	8,948

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	----------	----------	----------	----------	----------	----------	$19,854
1959	----------	----------	----------	----------	----------	----------	20,334
1960	1	$1	----------	----------	----------	----------	19,516
1961	----------	----------	(4)	(5)	----------	----------	19,643
1962	----------	----------	3	$1	----------	----------	20,327
1963	1	(6)	4	1	----------	----------	20,336
1876–1963	108	38	504	72	265	$56	839,406

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes re-treated, and ore or old tailings shipped directly to smelter during the calendar year indicated.
[2] Does not include gravel washed.
[3] Data not available.
[4] Less than 0.5 ton.
[5] Valued at $52.
[6] Valued at $493.

Copper.—Output of copper came from stockpiled ore mined by American Mining & Smelting, Inc., 2 years ago at the Blue Lead mine in Pennington County. This was the first year since 1960 that copper production was attributed to the State.

Gold and Silver.—With output of gold just about the same as that of 1962, the State, for the 15th consecutive year, continued to lead the Nation in gold production. The value of gold output accounted for 40 percent of the total production in the United States and 37 percent of the State total value of mineral production.

Silver production increased 4,249 ounces or 4 percent in quantity, and $27,381 or 22 percent in value over that of 1962. The reason for the greater percent increase in value was that the average price increased from $1.085 per ounce to $1.279.

Except for 3 ounces of gold and 929 ounces of silver produced from two small operations (Sandra Sue mine in Pennington County and Silver Queen mine in Lawrence County), the gold and silver was obtained from ore mined at the Homestake mine of Homestake Mining Co. The Homestake mine at Lead was the Nation's largest gold producer, as it was in 1962.

Iron Ore.—No iron-ore production was reported, thereby ending consecutive output since 1960. The State-owned cement plant at Rapid City used iron ore from plant stockpiles as an additive in making certain types of cements. The State Geological Survey revealed discovery of three magnetic-high anomalies, two in Day County and one in Marshall County. Intensity readings compared favorably with those taken at the Mesabi Range in Minnesota.

Lead.—Output of lead came from ores produced by American Mining & Smelting, Inc., at the Silver Queen mine in Lawrence County and by Frank Sterling at the Sandra Sue mine in Pennington County.

Uranium Ore.—Output of uranium ore was 2½ times as much as that of 1962: 72,088 tons was produced compared with 29,452 tons in 1962. The uranium ore averaged 0.31 percent uranium oxide (U_3O_8), whereas in 1962 it averaged 0.18 percent. The increase in tonnage and grade was due to production of uranium-bearing lignite in Harding County, the first production reported since 1960.

Production of uranium ore was attributed to 37 operations compared with 29 in 1962. Nineteen of the operations were in Fall River County, 14 in Harding, 3 in Custer, and 1 in Pennington.

In September, Susquehanna-Western, Inc., installed a portable burner near Buffalo for treating uranium-bearing lignite. Ore stockpiled at Buffalo and at mines before the installation and some ore mined after the installation were reduced to ash and then shipped for processing to the Edgemont mill of Mines Development, Inc., a subsidiary of Susquehanna-Western, Inc.

Kermac Nuclear Fuels Corp. mined and stockpiled uranium-bearing lignite ores from its properties in the Cave Hills area for treatment at the company permanent burning facility under construction at Bowman, N. Dak.

Vanadium.—Production of vanadium nearly tripled over that of 1962. Vanadium in the form of vanadium pentoxide (V_2O_5) was recovered from uranium ores processed at the Edgemont mill of Mines Development, Inc.

MINERAL FUELS

Coal (Lignite).—Production of coal (lignite) was 1,000 tons less than in 1962. The entire reported output of 17,000 tons came from the strip mine of Dewey County Coal Co. in Dewey County.

Petroleum.—Output of petroleum (crude) increased 18,000 barrels or 11 percent over that of 1962. Production was reported from 21 wells in the Buffalo field in Harding County and from 2 wells in the Barker Dome field in Custer County; in 1962 the number of producing wells for these fields was 19 and none, respectively. The two additional producing wells in the Buffalo field and one of the two wells in the Barker Dome field were drilled in 1963.

Drilling activity based on information furnished by the South Dakota State Geologist showed an increase over that of 1962: 18 wells, 7 development and 11 exploratory, were completed, compared with 11 wells in 1962. Five of seven development wells completed were successful; the other 2 development wells and all 11 of the exploratory wells were dry holes. The most significant activity was in Custer County; three of the four development wells completed in the county hit oil. No exploratory wells were drilled in Custer County. Harding County had one exploratory well and three development wells of which two were successful. Fall River County had three exploratory wells. Butte, Stanley, and Jackson Counties each had two exploratory wells. Ziebach County had one exploratory well. Footage drilled for the new wells totaled 87,095. The depths of individual wells varied from 1,385 to 8,759 feet. The shallower wells were in Custer County, the deeper ones in Harding County. An old well in Harding County was redrilled and deepened an additional 2 feet but was unsuccessful. At yearend two wells were being drilled in Custer County. All these wells were drilled with rotary tools.

Wyco Pipeline Co. completed construction of a 189-mile branch pipeline between Douglas, Wyo., and Rapid City and completed a pipeline terminal at Rapid City to handle about 1 million gallons of products annually from refineries at Casper, Wyo.

REVIEW BY COUNTIES

Of the 67 counties in the State, only Jones and Washabaugh had no reported mineral production. Table 10 shows the value of mineral output and the kinds of minerals produced in the counties. Only those counties with significant production are discussed in this review.

Butte.—The county mineral production exceeded that of 1962. Each of the three commodities produced—clays, sand and gravel, and lime—had substantial increases in output. Bentonite, mined by American Colloid Co. near Belle Fourche and in Crook County, Wyo., was processed at the company Belle Fourche plant. In June the company leased State-owned land west of Belle Fourche for mining bentonite; a previous lease had expired in 1962. At the Belle Fourche plant of IMC, only bentonite from the company operations in Crook County, Wyo., was processed. Black Hills Clay Products Co. mined clay near Belle Fourche for making brick and tile. Quicklime was made in the Utah-Idaho Sugar Co. sugar factory at Belle Fourche. A record

TABLE 10.—Value of mineral production in South Dakota, by counties

County	1962	1963 [1]	Minerals produced in 1963 in order of value
Aurora	$32,100	$145,000	Sand and gravel.
Beadle	81,290	265,973	Sand and gravel, stone.
Bennett		13,000	Sand and gravel.
Bon Homme	115,600	180,537	Sand and gravel, stone.
Brookings	289,700	(2)	Do.
Brown	272,107	304.836	Do.
Brule	47,402	356,000	Sand and gravel.
Buffalo	62,940	166,000	Do.
Butte	725,209	(2)	Clays, sand and gravel, lime.
Campbell	170,347	17,000	Sand and gravel.
Charles Mix	164,778	95,773	Sand and gravel, stone.
Clark	196,831	118,000	Sand and gravel.
Clay	31,500	70,000	Do.
Codington	346,400	410,000	Do.
Corson	171,677	321,081	Sand and gravel, stone.
Custer	702,307	1,038,798	Stone, uranium ore, feldspar, sand and gravel, vanadium, lime, gem stones, petroleum, mica (sheet), beryllium concentrate.
Davison	98,900	97,000	Sand and gravel.
Day	129,900	253,000	Do.
Deuel	100,300	111,331	Sand and gravel, stone.
Dewey	101,510	107,872	Coal, sand and gravel.
Douglas	63,300	338,309	Sand and gravel, stone.
Edmunds		70,000	Sand and gravel.
Fall River	282,286	312,816	Uranium ore, vanadium, sand and gravel, stone.
Faulk	184,019	157,000	Sand and gravel.
Grant	2,437,093	3,692,773	Stone, sand and gravel.
Gregory	127,908	124,000	Sand and gravel.
Haakon	126,300	284,000	Do.
Hamlin	67,431	134,000	Do.
Hand	64,400	285,000	Do.
Hanson	617,228	617,204	Stone, sand and gravel.
Harding	(2)	2,211,875	Uranium ore, petroleum, sand and gravel.
Hughes		251,000	Sand and gravel.
Hutchinson	80,207	403.203	Sand and gravel, stone.
Hyde	48,840	54,000	Sand and gravel.
Jackson	68,966	69,005	Sand and gravel, gem stones.
Jerauld	14,000	414,000	Sand and gravel.
Jones	7,500		
Kingsbury	292,237	189,000	Sand and gravel.
Lake	114,200	242,000	Do.
Lawrence	20,574,158	20,767,795	Gold, sand and gravel, silver, stone, lead, gem stones.
Lincoln	177,600	257,000	Sand and gravel.
Lyman	76,600	417,000	Do.
Marshall	277,700	162,000	Do.
McCook	1,250	182,194	Sand and gravel, stone.
McPherson	73,547	122,542	Do.
Meade	455,455	504,649	Do.
Mellette	43,100	70,000	Sand and gravel.
Miner	159,079	225,000	Do.
Minnehaha	1,807,880	2,734,878	Stone, sand and gravel.
Moody	149,200	234,000	Sand and gravel.
Pennington	11,016,445	9,351,442	Cement, stone, sand and gravel, clays, gypsum, mica (scrap), feldspar, lithium minerals, gem stones, copper, unanium ore, gold, lead, silver.
Perkins	174,821	180,000	Sand and gravel.
Potter	29,700	191,000	Do.
Roberts	269,851	255,240	Sand and gravel, stone.
Sanborn	9,300	39,000	Sand and gravel.
Shannon		5,000	Do.
Spink	258,186	205,000	Do.
Stanley		37,452	Sand and gravel, stone.
Sully	12,600	63,000	Sand and gravel.
Todd		14,000	Do.
Tripp		1,000	Do.
Turner	344,100	940,218	Sand and gravel, stone.
Union	44,600	95,000	Sand and gravel.
Walworth	116,500	303,000	Do.
Washabaugh	866		
Yankton	77,300	134,000	Sand and gravel.
Ziebach	75,500	37.000	Do.
Undistributed [3]	[4] 1,125.035	3,609,696	
Total	[4] 45,787,000	55,058,000	

[1] Value of petroleum is preliminary.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes production of some sand and gravel and gem stones that cannot be assigned to specific counties and values indicated by footnote 2.
[4] Revised figure.

output of sugar at the plant resulted in a large increase in quicklime production. Output of sand and gravel went from 238,000 tons in 1962 to 775,000 tons, used almost entirely for road construction and maintenance.

Custer.—From among the 10 minerals produced within the county, stone, uranium ore, and feldspar had mineral production worth over $100,000.

The most important mineral activity was petroleum production. During 1962 the only producing oil well in the county had been inactive. The well, which was the discovery of the Barker Dome field, was worked over by a new owner in 1963 and produced oil from April to the end of the year. Three of the four development wells drilled in the latter part of the year were successful; one of these three wells attained production before yearend.

The county output of feldspar—19,515 long tons valued at $125,443, representing about three-fourths of the State output—was nearly 9,000 long tons and $58,000 below that of 1962. Feldspar was produced from 24 operations, compared with 44 operations in 1962. Beryllium-concentrate production was obtained from 1 operation, whereas in 1962 there were 20 operations. Some punch-and-washer-grade sheet mica, mined before this year, was sold during 1963. The value of gem stones was about $14,000, representing 70 percent of State total value of gem stones. Agate, chalcedony, and quartz were the most widely collected gem materials. Output of uranium ore was about one-third less than that of 1962; only three uranium operations reported production, compared with nine in 1962. However, more vanadium was recovered from the uranium ore than in 1962. The uranium mines were operated by Susquehanna-Western, Inc., and Wayne Sundstrom.

Hills Materials Co. started a new large crushed-limestone operation 6 miles south of Pringle. The new operation was responsible for a substantial increase in stone production. Limestone used as riprap was produced by a contractor of the Federal Bureau of Reclamation. Black Hills Lime Co. mined high-calcium limestone and made quicklime from the limestone at its operation near Pringle. About two-thirds of the sand and gravel produced was used for the road construction project of State Highway 89 between Pringle and Minnekahta. Some sand and gravel was used on construction projects of the Federal Forest Service and Federal Bureau of Reclamation.

Fall River.—The value of the four mineral commodities produced was $312,816, an increase of $30,000 over that of 1962. Greater outputs of uranium ore and vanadium offset the drops in production of stone and sand and gravel. The uranium ore and vanadium came from mines operated by Ray Bettenhausen, Black Hills Uranium Co., Walter L. McKenna, Wayne Sundstrom, and Susquehanna-Western, Inc. Mines Development, Inc., a subsidiary of Susquehanna-Western, Inc., operated its uranium mill at Edgemont. In addition to uranium ores, ash, obtained from burning uranium-bearing lignite, was processed at the mill. Crushed limestone was produced by Flyte Rock Products. One Government-contractor and three commercial operations produced the sand and gravel. Oil exploration continued; however, the three exploratory wells completed were unsuccessful.

Grant.—Although only stone and sand and gravel were produced in Grant County, their combined output value totaled nearly $3.7 million, which was surpassed by only two other counties. The output value represented an increase of about $1.2 million, or 52 percent over that of 1962. Sand and gravel production, increasing in value from $12,900 to $940,000, accounted for most of the change. Virtually all of the output of sand and gravel was produced by the Grant County Highway Department for road construction and maintenance. A small amount of gravel was produced by a commercial operator for use as fill. Dimension granite, valued at about $300,000 more than that of 1962, accounted for about $2.7 million, or three-fourths of the county value. The stone was quarried by Cold Spring Granite Co., Dakota Granite Co., Delano Granite Works, Inc., North Star Granite Corp., Robert Hunter Granite Co., Inc., and Steiner-Rausch Granite Co.

Harding.—Value of output of the three commodities—petroleum, sand and gravel, and uranium ore—totaled $2.2 million, exceeding the $1.0 million mark for the first time. Uranium-ore production, all from uranium-bearing lignite, was mainly responsible for the large county value; this was the first year since 1960 that such production was recorded for the county. The output of uranium ore came from 14 operations—9 of Kermac Nuclear Fuels Corp., 2 of Bryco Mining Co.; and 1 each of Joe Kalina, Fred Laflin, and W. L. Munkres. Near Buffalo, Susquehanna-Western, Inc., installed and operated a portable burner for reducing uranium-bearing lignite to ash for processing at the Edgemont mill of Mines Development, Inc. Output of sand and gravel was about twice that of 1962. The sand and gravel, produced by a contractor of the South Dakota Department of Highways, was used for road construction. Production of petroleum (crude) came from 21 wells in the Buffalo field; however, only 18 wells pumped throughout the year. One of the 21 wells produced only in January. Two of the three completed development wells were successful and had attained production in the last half of the year. The only exploratory well completed was dry. Zapata Petroleum Corp., which in 1962 had purchased the producing wells of Shell Oil Co., became part of Pennzoil Co.

Lawrence.—Mineral production, valued at nearly $20.8 million, set a new county high for the State; the previous record, established in 1962 by the same county, was surpassed by about $200,000. Although the values of gold and stone outputs were below those of 1962, the increases in value of silver and sand and gravel were large enough to more than offset those losses. Gold production, about 500 ounces less than that of 1962, accounted for 97 percent of the total county value. Except for 1 ounce of gold and about 1,000 ounces of silver, the county output of gold and silver was produced by Homestake Mining Co.

According to the Homestake Mining Co. 1963 annual report to the stockholders, an alltime record total of 1,909,261 tons of ore from the gold mine at Lead was treated at the Homestake mill. The value of bullion (gold and silver) produced was $20,278,195, also a record. The recovered value per ton was $10.62 compared with $10.85 for 1962. Metallurgical recovery was 96.92 percent, 0.47 percent below that for 1962. Total direct operating costs increased 56 cents per ton, and general costs increased 12 cents per ton. Production from stoping

below the 4,850-foot level had reached 400 tons of ore per day by yearend. Tonnage from this area was expected to increase to 800 tons per day during 1964. Development of the West Ledge (the westernmost structure in the mine) on the 5,900-foot level had reached the area of mineralization projected from the 4,850-foot level. At yearend the new storage area contained more than 14,000 tons of crushed ore available to assure a more uniform milling rate when mine production temporarily fails to meet mill capacity.

TABLE 11.—Homestake mine ore milled, receipts, and dividends[1]

Year	Ore milled (thousand short tons)	Receipts for bullion product		Dividends (thousands)
		Total (thousands)	Per ton	
1959	1,746	$20,120	$11.52	$4,019
1960	1,767	19,465	11.02	4,021
1961	1,781	19,590	11.00	4,030
1962	1,869	20,271	10.85	3,242
1963	1,909	20,278	10.62	3,265

[1] From 1876 to 1963, inclusive, this mine yielded bullion and concentrates that brought a net return of $758.2 million and paid $221.4 million in dividends.

Source: Homestake Mining Co. annual report to stockholders.

Some gold, silver, and lead was obtained from ores shipped by American Mining & Smelting, Inc., from the Silver Queen mine. In November, Silver Security Mines, Inc., obtained a lease to operate the Silver Queen mine and purchased the Pioneer Tungsten Mines, Inc., mill located about 4 miles northwest of the mine. The mill was to be used for processing ore from the Silver Queen mine. New Era Mining Co. constructed plant facilities at its properties on Whitewood Creek about 1 mile downstream from Deadwood and expected to attain production in 1964.

Contractors for the Federal Forest Service, South Dakota Department of Highways, and Lawrence County Highway Department produced a total of 471,000 tons of sand and gravel for road construction and maintenance. The output of sand and gravel was 223,000 tons more than that of 1962. Stone production was about 14,000 tons below the 1962 output of 71,000 tons. Cole Construction Co. produced crushed limestone for road construction and for making lime. A contractor for the Lawrence County Highway Department produced crushed limestone for road construction. The balance of the stone was crushed granite used by the city of Lead. The only reported gem material collected was jasper, valued at $50.

Minnehaha.—The county was ranked first in the State in production of sand and gravel. The output of 1.8 million tons, valued at nearly $1.3 million, was twice that of 1962. Stone production, all consisting of crushed sandstone (quartzite), accounted for the balance of the county value of mineral production. Most of the sand and gravel and stone went into roadbuilding, especially for sections of Interstate Highways 29 and 90 under construction within the county.

Pennington.—Pennington County was again ranked second according to county value of mineral production. Fourteen of the nineteen mineral commodities produced in the State were recorded in this county. The value of this production was $9.4 million, a decrease of $1.7 million below the county value of 1962. The biggest drop in output was cement, whose production value was $1.4 million below that of last year. However, the cement-production value of $6.1 million accounted for about two-thirds of the total county value. The total State output of cement was produced at the State-owned cement plant in Rapid City. In conjunction with the operation of the plant, the South Dakota Cement Commission produced limestone, shale (clay), and gypsum. Stone production of 1.2 million tons was 288,000 tons below that of 1962. Limestone produced by the South Dakota Cement Commission for making cement was 177,000 tons less than output in 1962. Hills Materials Co., L. G. Everist, Inc., and Pete Lien & Sons produced crushed limestone. Some dimension limestone was quarried for use as rough building stone and flagging. Construction of a lime plant at Rapid City was about three-fourths completed at yearend. The plant, owned by Rapid City Lime Co., was expected to be in operation about mid-1964. Lightweight Aggregates, Inc., mined clay for lightweight aggregates. The output of feldspar from the six producing mines was 6,075 long tons, an increase of about 4,700 long tons over 1962 production from seven mines. In addition to feldspar, Hough & Judson obtained some lithium ore from the Hugo Lode. The output of scrap mica came from the Peerless mine operated by Northwest Beryllium Co. Gem material collected was valued at about $5,000. The Blue Lead mine was credited with copper and lead production obtained from stockpiled ore. Uranium ore was produced by Walter Wilk from the Rube No. 1 mine. Sand and gravel production was 1.1 million tons, a decrease of about 200,000 tons from that of 1962. The output was produced from 4 commercial and 19 Government-and-contractor operations.

Turner.—Sand and gravel production went from 494,000 tons in 1962 to 1.6 million tons, which was the second highest county production for the year. The only other mineral production in the county was 1,200 tons of crushed stone. All of the stone and gravel and most of the sand were used in road construction; some sand was used for building construction.

The Mineral Industry of Tennessee

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Tennessee Division of Geology for collecting information on all minerals except fuels.

By James R. Boyle [1] and William D. Hardeman [2]

RECORD production of masonry cement, ball clay, crushed limestone, sand and gravel, and zinc, highlighted the mineral industry of Tennessee in 1963. Tennessee led the Nation in production of ball clay, pyrite, and zinc; ranked second in output of phosphate rock and dimension marble; and fourth in production of fuller's earth and dimension sandstone. The total value of mineral production was 4 percent more than in 1962, the previous record year.

TABLE 1.—Mineral production in Tennessee [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	13,797	$229	24,082	$404
Cement:				
Masonry—thousand 280-pound barrels	1,089	2,931	1,161	3,079
Portland—thousand 376-pound barrels	8,509	27,741	8,283	26,760
Clays [2]—thousand short tons	1,037	4,597	1,238	5,248
Coal (bituminous)—do	6,214	22,555	6,121	22,689
Copper (recoverable content of ores, etc.)—short tons	14,298	8,808	13,717	8,450
Gem stones	[3]	1	[3]	[4]
Gold (recoverable content of ores, etc.)—troy ounces	158	6	137	5
Lead (recoverable content of ores, etc.)—short tons	51	9		
Natural gas—million cubic feet	75	14	90	17
Petroleum (crude)—thousand 42-gallon barrels	14	[5]	[6] 15	[5]
Phosphate rock—thousand long tons	2,418	19,868	2,352	17,876
Sand and gravel—thousand short tons	6,075	8,018	7,613	9,443
Silver (recoverable content of ores, etc.)—troy ounces	112,251	122	107,913	138
Stone—thousand short tons	24,398	35,614	26,825	38,113
Zinc (recoverable content of ores, etc.)—short tons	71,548	16,456	95,847	22,045
Values of items that cannot be disclosed: Fuller's earth, iron ore, lime, pyrite, and values indicated by footnote 4		[7] 7,050		6,456
Total		[7] 154,019		160,723

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes fuller's earth; included with "Values of items that cannot be disclosed."
[3] Weight not recorded.
[4] Less than $500.
[5] Figure withheld to avoid disclosing individual company confidential data.
[6] Preliminary figure.
[7] Revised figure.

[1] Mining engineer, Bureau of Mines, Knoxville, Tenn.
[2] State geologist, Division of Geology, Department of Conservation, Nashville, Tenn.

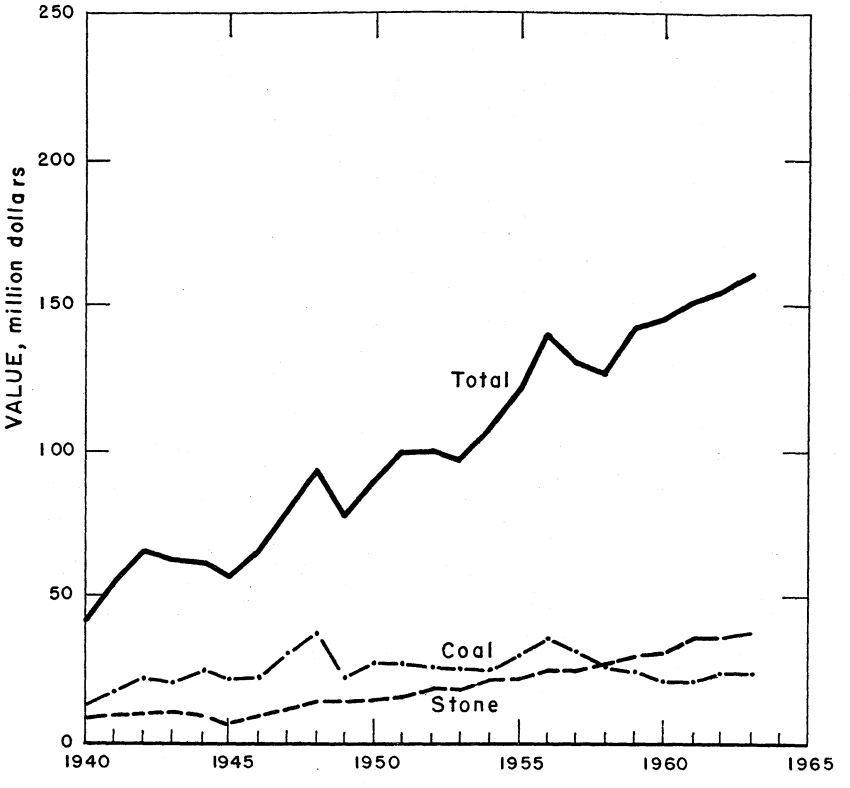


FIGURE 1.—Value of stone, coal, and total value of mineral production in Tennessee, 1940–63.

Leading industries were copper and zinc mining, stone quarrying, cement manufacturing, coal mining, phosphate rock mining and processing, and sand and gravel mining, which together furnished 92 percent of the total value of production. Leading companies were Tennessee Copper Co. (gold, silver, copper, pyrite, and zinc), American Zinc Co. of Tennessee (zinc and limestone), Monsanto Chemical Co. (phosphate rock), Penn-Dixie Cement Corp. (cement, limestone, and clay), Ideal Cement Co. (cement, limestone, and clay), Marquette Cement Mfg. Co. (cement, limestone, and clay), Signal Mountain Division of General Portland Cement Co. (cement and limestone), and Lambert Bros. (crushed limestone).

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$109,356	1958	$129,526
1953	102,220	1959	141,534
1954	111,573	1960	142,823
1955	122,258	1961	151,067
1956	135,601	1962	154,268
1957	130,190	1963	161,515

Trends and Developments.—New Market Zinc Co., completed its 1,800 foot deep shaft. Production of 2,400 tons per day will be started in 1964. American Zinc Co. was sinking a shaft to develop the Immel mine in Knox County. Mine production by 1967 will be 2,000 tons per day. American Zinc Co. was reopening its North Friends Station mine, closed since 1957. It was sinking a shaft approximately 400 feet and production of 500 tons per day will commence by late 1964.

New Jersey Zinc Co. planned to reopen the Flat Gap mine at Treadway.

The Tennessee Valley Authority (TVA) Melton Hill Dam in Loudon County was completed early in 1963. The TVA Bull Run Steam Plant, being built on the shore of the Melton Hill reservoir in Anderson County, is scheduled for completion in 1965. The initial capacity of the plant will be 900,000 kilowatts. TVA is planning construction of the Nickajack Dam to replace Hales Bar Dam, on the Tennessee River below Chattanooga. Construction of the dam is scheduled to begin in 1964 and to be completed by 1967. The dam will be 3,700 feet long and 83 feet high.

Consolidated Aluminum Corp. began operation of its 20,000-ton-per-year aluminum-ingot smelter in Humphreys County. A $10 million expansion program has been initiated to lengthen the present potline, bringing capacity to 31,000 tons per year by mid-1964 and to construct a second potline, bringing capacity to 62,000 tons per year by mid-1965.

Leonard Construction Co. of Chicago was constructing a $5 million contact-process sulfuric acid plant for Tennessee Copper Co. at Copperhill. The plant with a designed rated capacity of 850 tons per day is expected to be in operation by the end of 1964. The metallurgical gas plant will produce acid from SO_2.

Water.—The Bureau of Mines canvassed the mineral producers in 1963 for water usage in 1962. Of the total water used, 63 percent was recirculated. Nonmetal mines and mills was the largest consumer, using nearly 95 percent, followed by metal mines and mills, using nearly 5 percent, with the balance of less than 1 percent being used by quarries and mills, coal (bituminous), sand and gravel mines, and petroleum and natural gas operations.

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

Industry	New water	Recirculated water	Total water use
Quarries and mills	202	5	207
Coal, bituminous	(1)		(1)
Metal mines and mills	4,310	2,746	7,056
Nonmetal mines and mills	52,417	93,733	146,150
Sand and gravel mines	374	684	1,058
Petroleum and natural gas	49		49
Total	57,352	97,168	154,520

[1] Less than 1 million gallons.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—Two operators mined crude barite from three mines in two counties for oil-well-drilling muds, chemicals, and other uses. The leading producer was J. M. Godsey, Athens mine. Production increased 75 percent but was still 77 percent below that in 1941, the record year.

Cement.—Four companies produced masonry cement at five plants in five counties; the leading producer was Marquette Cement Manufacturing Co. Shipments increased 7 percent above those in 1962, the previous record year. Consumption in Tennessee was 55 percent, and shipments were made to North Carolina (18 percent), Georgia (12 percent), South Carolina (5 percent), Kentucky (3 percent), Alabama (3 percent), Virginia (3 percent), and other States (1 percent).

Four companies produced portland cement at six plants in six counties. The leading producer was Penn-Dixie Cement Co. Shipments decreased 3 percent below those in 1962, the previous record year. Raw materials used in cement included limestone (86 percent), clays and shale (8 percent), gypsum (3 percent), and other (3 percent). Consumption in Tennessee was 48 percent, and shipments were made to North Carolina (22 percent), Georgia (19 percent), Alabama (3 percent), Virginia (3 percent), Kentucky (2 percent), South Carolina (2 percent) and other States (1 percent).

Portland cement was used as follows: In ready-mixed concrete (56 percent), in concrete products (18 percent), by highway contractors (14 percent), by building-materials dealers (6 percent), and in other ways (6 percent).

Clays.—Tennessee led the Nation in producing ball clay. Five companies operated six mines in Henry and Weakley Counties; leading producers were H. C. Spinks Clay Co., Inc., and United Clay Mines Corp. Production increased 15 percent compared with that of 1962, the previous record year.

Southern Clay Co., Inc. and Tennessee Absorbent Clay Co. mined fuller's earth in Henry County for absorbent use. Production increased 8 percent. Tennessee ranked fourth in the Nation in production of fuller's earth.

Ten companies mined miscellaneous clay at 13 mines in 9 counties for building brick, heavy clay products, lightweight aggregate, and cement. Leading counties were Knox, Sullivan, and Davidson; leading producers were General Shale Products Corp., and W. G. Bush & Co., Inc. Production increased 21 percent but was 15 percent below the record in 1956.

TABLE 4.—Ball clay sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Whiteware, etc.	187,088	$2,543,442	$13.59	211,738	$2,985,339	$14.10
Floor and wall tile	50,900	733,334	14.41	55,300	772,829	13.98
Other uses [1]	71,517	883,074	12.35	88,324	918,802	10.40
Total	309,505	4,159,850	13.44	355,362	4,676,970	13.16

[1] Includes foundries and steelworks (1962); firebrick and block; saggers, pins, stilts, and wads; heavy clay products; enameling; exports; and other uses.

Feldspar.—The Feldspar Corp. plant at Erwin ground crude feldspar from North Carolina for pottery.

Gem Stones.—Collection of gem stones was reported from six counties. Bedford was the leading county, and agate was the predominate gem stone.

Lime.—Foote Mineral Co., formerly Standard Lime & Cement Co., Knoxville, and Williams Lime Mfg. Co., Knoxville, produced quicklime and hydrated lime for building and chemical uses. Production increased 8 percent. Consumption in Tennessee was 42 percent, and shipments were made to North Carolina (32 percent), Kentucky (11 percent), Ohio (6 percent), South Carolina (5 percent), and other States (4 percent).

Mica.—Carolina Southern Mining Co., Inc., at Erwin produced ground mica for welding rods and joint cement from scrap mica shipped from North Carolina.

Perlite.—Chemrock Corp., formerly Tennessee Products & Chemical Corp., expanded crude perlite from Colorado at the Nashville plant.

Phosphate Rock.—Seven companies mined and processed phosphate rock in Davidson, Giles, Hickman, Maury, Sumner, and Williamson Counties. Leading producers were Monsanto Chemical Co. and Victor Chemical Works. Marketable production decreased 3 percent below that in 1962, the record year. Tennessee ranked second in the Nation in the production of phosphate rock.

V–C Corp. was modernizing existing nodulizing and rock-washing facilities at Mt. Pleasant, which will double capacity.

Pyrite.—Tennessee Copper Co. recovered pyrite concentrate from sulfide ore mined in Polk County. Production decreased 4 percent below that in 1962 and was 6 percent below the record year of 1957. Tennessee continued to lead the Nation in output of pyrite.

Sand and Gravel.—Thirty-six commercial operators mined sand and gravel at 40 locations in 26 counties. Government-and-contractor pro-

duction amounted to 9 percent of the total mined. There were six Government-and-contractor operators at six locations in six counties. Leading counties were Shelby, Benton, and Davidson. Leading commercial producers were Hadley Contracting Co., Inc.; Ingram Materials, Inc.; and Cordova Sand & Gravel Co., Inc. Production increased 25 percent and was 21 percent above the previous record year of 1960. Of the total production, 93 percent was washed. Transportation was as follows: 82 percent was hauled by truck, 16 percent by rail, and 2 percent by water.

TABLE 5.—Phosphate rock sold or used by producers, by uses

Use	1962			1963		
	Long tons	Value		Long tons	Value	
		Total	Average per ton		Total	Average per ton
Elemental phosphorus	2,366,022	$19,079,090	$8.06	2,257,567	$16,848,592	$7.46
Ordinary superphosphate	[1] 55,538	[1] 543,733	[1] 9.79	[2] 137,831	[2] 1,453,976	[2] 10.54
Direct application to the soil	54,523	549,757	10.08	(3)	(3)	(3)
Total	2,476,083	20,172,580	8.15	2,395,398	18,302,568	7.64

[1] Includes fertilizer filler and pig-iron blast furnace.
[2] Includes direct application to the soil, triple superphosphate, pig-iron blast furnace, and fertilizer filler.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Ordinary superphosphate."

Stone.—Fifty-nine commercial operators crushed limestone at 87 quarries in 52 counties. Government-and-contractor production amounted to 7 percent of the total crushed limestone and was produced at 29 quarries in 22 counties. Leading commercial producers were Lambert Bros. (Blount, Claiborne, Davidson, Hawkins, Humphreys, Knox, Roane, Sevier, Sullivan, and Williamson Counties) and Hoover, Inc. (Davidson and Dixon Counties). Production increased 10 percent above that of the previous record year, 1962. Of the total commercial production, 89 percent was hauled by truck, 9 percent by rail, and 2 percent by waterway.

John J. Craig Co., Knoxville Crushed Stone Co., Appalachian Marble Co., and Tennessee Marble Co. crushed marble for terrazzo and other uses. Production decreased slightly and was 36 percent below the record in 1948. John J. Craig Co. (Hamil, Marmor, Crisp, and Lee quarries), Gray Knox Marble Co. (Gray, Knox, and Brown quarries), Tennessee Marble Co. (Eagle, Luttrell, and Endsley quarries), Appalachian Marble Co. (Bond and Appalachian quarries), and Imperial Black Marble Corp. (Thornhill quarry) quarried dimension marble in Blount, Grainger, Knox, and Union Counties. Production decreased 27 percent and was 49 percent below the record in 1957. Tennessee ranked second in production of dimension marble. Sewanee Silica Co., White Silica Sand Co., and Turner Bros. Stone Co., Inc. crushed sandstone. Production decreased 14 percent compared with that in 1962, the record year. Twelve companies quarried dimension sandstone at 12 quarries in Cumberland, Fentress, and Morgan Counties for rough architectural, sawed and dressed building

stone, and flagging. Leading producers were Tennessee Stone Co., Inc. and Crab Orchard Stone Co., Inc. Production increased 4 percent but was 48 percent below the record in 1955. Tennessee ranked fourth in production of dimension sandstone.

TABLE 6.—Sand and gravel sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Benton	716,644	$1,222,594	817,028	$1,282,008
Cumberland	63,000	95,850	63,000	87,000
Fayette			107,000	107,000
Gibson			(1)	(1)
Giles			200,000	200,000
Greene	(1)	(1)		
Grundy	72,000	120,000	84,000	134,400
Hardeman	(1)	(1)	57,740	67,500
Haywood	67,670	54,000	58,800	45,900
Lauderdale	65,324	54,872	77,300	60,300
Loudon	(1)	(1)	14,734	22,506
Monroe	30,046	44,350	22,030	34,125
Obion	122,994	45,553	(1)	(1)
Polk			8,148	15,972
Sevier	27,700	30,100	(1)	(1)
Shelby	1,622,779	1,405,257	1,524,853	1,393,862
Tipton	304,279	264,066	(1)	(1)
Unicoi	(1)	(1)	280,496	449,567
Undistributed [2]	2,982,749	4,681,128	4,298,103	5,543,294
Total	6,075,185	8,017,770	7,613,232	9,443,434

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes Bradley, Carroll, Davidson, Decatur, Franklin, Hamilton, Henderson, Humphreys, Knox, McNairy, Putnam, Stewart, and Wayne Counties, and where indicated by footnote 1.

TABLE 7.—Sand and gravel sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	1,953,767	$3,052,283	$1.56	1,832,622	$2,735,068	$1.49
Paving	719,830	817,737	1.14	857,259	1,251,740	1.46
Molding	225,147	678,046	3.01	245,664	738,045	3.00
Fire or furnace				6,668	13,336	2.00
Engine	1,508	2,262	1.50	1,161	1,741	1.50
Other sand	(1)	(1)	(1)	[2] 456,655	[2] 859,803	[2] 1.88
Total	(1)	(1)	(1)	3,400,029	5,599,733	1.65
Gravel:						
Paving	1,432,381	1,118,307	.78	2,875,395	2,367,995	.82
Structural	1,031,833	1,282,457	1.24	1,140,450	1,325,136	1.16
Railroad ballast	(1)	(1)	(1)	50,000	67,500	1.35
Other gravel	(1)	(1)	(1)	[3] 147,358	[3] 83,070	[3] .56
Total	(1)	(1)	(1)	4,213,203	3,843,701	.91
Total sand and gravel	6,075,185	8,017,770	1.32	7,613,232	9,443,434	1.24

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Total sand and gravel."
[2] Includes grinding and polishing, other construction, fill, and glass sand.
[3] Includes fill and miscellaneous gravel.

TABLE 8.—Crushed limestone sold or used by producers, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Blount	(1)	(1)	455,117	$627,749
Claiborne	(1)	(1)	162,724	214,761
Clay	(1)	(1)	87,333	131,000
Cocke	41,450	$50,000	58,418	87,627
Cumberland	390,146	511,757	(1)	(1)
Davidson	2,576,156	2,964,789	2,938,181	3,197,578
De Kalb	31,879	31,879		
Dickson			(1)	(1)
Fentress	134,400	177,000	127,493	169,926
Franklin	859,301	1,113,035	745,398	1,001,125
Giles	200,000	250,000	(1)	(1)
Grainger			29,544	25,100
Grundy	83,100	105,975	55,650	71,675
Hamblen	(1)	(1)	344,396	462,144
Hawkins	(1)	(1)	144,100	198,941
Hickman			(1)	(1)
Humphreys	(1)	(1)	685,237	833,287
Knox	2,688,024	4,490,048	2,716,986	4,397,159
Lawrence	(1)	(1)		
Loudon			500	600
Macon	85,000	115,000	80,000	100,000
Marion	936,010	1,196,321	1,051,392	1,304,096
Montgomery	477,745	595,957	(1)	(1)
Pickett	35,968	44,959	16,625	36,250
Putnam	420,000	537,500	(1)	(1)
Roane	(1)	(1)	386,375	454,244
Sevier	(1)	(1)	256,335	364,878
Sumner	336,539	439,238	(1)	(1)
Unicoi			132,000	165,000
Union	8,750	10,850	23,500	29,375
Washington	202,711	243,153	194,702	242,064
White	322,800	328,920	281,865	317,537
Williamson	(1)	(1)	468,280	593,757
Undistributed [2]	14,244,101	18,024,353	15,099,368	19,016,501
Total	24,074,080	31,230,734	26,541,519	34,042,374

[1] Figure withheld to avoid disclosing individual confidential data; included with "Undistributed."
[2] Includes Anderson, Bedford, Bradley, Campbell, Cannon, Carter, Coffee, Decatur, Greene, Hamilton, Hardin, Jefferson, Johnson, Lincoln, Marshall, Maury, McMinn, Meigs, Monroe, Overton, Rhea, Robertson, Rutherford, Sequatchie, Sullivan, Warren, Wayne, and Wilson Counties, and counties indicated by footnote 1.

TABLE 9.—Crushed limestone sold or used by producers, by uses

Use	1962			1963		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	19,309,884	$24,103,718	$1.25	21,740,841	$26,707,845	$1.23
Cement and lime	2,284,061	3,705,760	1.62	2,214,884	3,433,844	1.55
Agstone	1,682,647	2,140,359	1.27	1,631,928	1,873,686	1.15
Stone sand	221,704	314,588	1.42	274,912	406,822	1.48
Mineral food	82,000	143,500	1.75	(1)	(1)	(1)
Fluxing stone	27,000	37,800	1.40	(1)	(1)	(1)
Rock dust for coal mines	7,700	15,400	2.00	(1)	(1)	(1)
Riprap	41,674	50,364	1.21	12,985	14,184	1.09
Other uses [2]	417,410	719,245	1.72	665,969	1,605,993	2.41
Total	24,074,080	31,230,734	1.30	26,541,519	34,042,374	1.28

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes railroad ballast, glass, paper, asphalt filler, fertilizer filler, other fillers, filter beds (1963), other uses, and uses indicated by footnote 1.

TABLE 10.—Dimension marble sold or used by producers, by uses

Use	1962			1963		
	Quantity cubic feet	Value		Quantity cubic feet	Value	
		Total	Average per cubic foot		Total	Average per cubic foot
Building stone:						
Rough	187,345	$655,169	$3.50	130,187	$475,688	$3.65
Sawed, dressed	167,881	479,565	2.86	194,714	711,700	3.66
Cut, dressed [1]	84,595	1,211,997	14.33	38,215	644,662	16.87
Total	439,821	2,346,731	5.34	363,116	1,832,050	5.05

[1] Includes a small quantity of monumental stone.

MINERAL FUELS

Coal (Bituminous).—Bituminous coal was mined at 266 mines in 17 counties, compared with 353 mines in 17 counties in 1962. Leading producing counties were Anderson, Campbell, and Scott. Leading producers were Pocahontas Fuel Co. (Morco mine), Clinchfield Coal Co. (Meadow Creek mine), and Wind Rock Coal & Coke Co. (Wind Rock No. 2 mine). Production was 1 percent less than in 1962 and 31 percent below the record in 1956. Average production per mine increased from 17,600 to 23,000 tons.

TVA purchased 62 percent of the coal mined in Tennessee, which amounted to 18 percent of TVA coal purchases.

In the northern part of the State (District 8), 195 mines in 10 counties produced 5,210,000 tons of coal, compared with 222 mines in 10 counties that produced 4,800,000 tons in 1962. Average production per mine increased from 21,600 to 26,700 tons. Underground mines produced 60 percent of the total; strip mines, 35 percent; and auger mines, 5 percent. Shipments were 61 percent by rail or water and 39 percent by truck. Captive tonnage was 1 percent of the total.

Equipment used at 142 underground mines included 106 cutting machines that cut 82 percent of the total tonnage; 118 power drills that drilled 81 percent; 77 locomotives, 45 shuttle cars, 5 mother conveyors, and 29 mobile loading machines that loaded 59 percent; 7 continuous mining machines that loaded 10 percent; and 24 face conveyors that loaded 5 percent. Equipment used at 45 strip mines included 63 power shovels, 3 draglines, 53 bulldozers, and 17 power drills. Equipment used at eight auger mines included eight coal recovery augers, one power shovel, and three bulldozers. Thirty-nine percent of the coal was crushed, and 2 percent was cleaned. The only cleaning plant was operated by Kopper-Glo Fuel, Inc., at Clairfield.

In the Southern part of the State (District 13), 71 mines in 7 counties produced 911,000 tons, compared with 131 mines in 7 counties that produced 1,413,000 tons in 1962. Average production per mine increased from 10,800 to 12,800 tons. Underground mines produced 32 percent of the total; strip mines, 68 percent. Shipments were 60 percent by rail or water and 40 percent by truck. The coal was sold in the open market, mainly to TVA.

Equipment used in 58 underground mines included 22 cutting machines that cut 66 percent of the total tonnage; 31 power drills that drilled 69 percent; 4 locomotives, 4 shuttle cars, 2 mother conveyers, and 2 mobile loading machines that loaded 8 percent. Equipment used at 13 strip mines included 25 power shovels, 6 draglines, 23 bulldozers, 9 power drills, and 26 trucks. Of the total tonnage, 28 percent was crushed.

TABLE 11.—Coal (bituminous) production, by counties

County	1962		1963	
	Short tons	Value	Short tons	Value
Anderson	1,589,141	$5,950,113	1,971,334	$7,546,290
Bledsoe	20,894	72,419	52,555	188,197
Campbell	1,336,977	4,606,208	1,384,810	4,963,898
Claiborne	380,737	1,288,664	351,433	1,216,722
Cumberland	34,564	138,256	34,613	97,608
Fentress	92,024	276,072	87,176	315,577
Grundy	192,162	796,100	213,220	991,600
Hamilton	31,778	108,395	48,090	198,443
Marion	642,831	2,811,642	249,791	1,040,277
Morgan	317,991	1,104,059	366,452	1,176,010
Overton	74,942	208,338	52,140	208,560
Pickett	4,000	16,000	1,200	4,476
Putnam	485,318	1,867,729	462,594	1,696,054
Rhea	27,656	93,753	13,386	45,378
Scott	484,490	1,485,370	497,937	1,737,291
Sequatchie	288,793	938,577	104,964	376,536
Van Buren	209,313	793,488	229,379	886,246
Total	6,213,611	22,555,183	6,121,064	22,689,163
Earliest record to date	406,502,000	(1)	412,623,000	(1)

[1] Data not available.

Coke.—Tennessee Products & Chemical Corp., recently purchased by Woodward Iron Co., produced metallurgical coke in byproduct coke ovens at Chattanooga. Chem-Coke, Inc., produced chemical coke at Columbia.

Natural Gas.—Marketable production of natural gas increased 20 percent. At the end of the year, 35 gas wells were producing. Cumulative production of natural gas since 1916 was 3,519 million cubic feet.

Petroleum.—Production of crude petroleum was 7 percent more than in 1962. At the end of the year 39 oil wells were producing. Cumulative production since 1916 was 661,000 barrels. According to Oil and Gas Journal, exploratory drilling continued in Tennessee; completions were reported from 12 counties. Twenty-nine holes were completed, with a total footage drilled of 21,929. Crude was hit in 3 holes. The crude was found in Clay County. This compares with 34 completions in 1962, of which gas was found in 3 and crude in 2 with a total footage drilled of 48,809.

METALS

Copper.—Tennessee Copper Co. recovered copper concentrate from sulfide ore mined in Polk County. Production of recoverable copper was 4 percent less than that of 1962, the record year. The company

has core drilled from stations below the 24 level of the Calloway mine, the deepest level in the district, and has encountered ore at the 30 level. This is the deepest ore yet located in the copper basin and is about 2,800 feet below the surface.

Ferroalloys.—Shipments of ferromanganese, silicomanganese, silvery pig iron, ferrosilicon, ferrochromium, ferrochromic silicon, and ferrophosphorus totaled 174,826 tons, valued at $21,752,000, an increase of 57 percent in tonnage and 21 percent in value from 1962.

Gold.—Tennessee Copper Co. recovered gold as a byproduct from smelting copper and zinc concentrates. Production decreased 13 percent and was 80 percent below the record set in 1930.

Iron Ore.—Big Flag Springs Mining Co. mined brown iron ore in Blount County. Production of iron ore decreased 76 percent, more than 99 percent below the record set in 1902.

Pig Iron.—Tennessee Products & Chemical Corp. produced foundry, basic. low phosphorus, malleable, and chromium bearing pig iron at Rockwood. Shipments increased slightly. Iron ore consumed was from Alabama, Georgia, Missouri, and Tennessee.

Silver.—Tennessee Copper Co. recovered silver as a byproduct from smelting copper and zinc concentrates. Production was 4 percent below that of 1962, the record year.

Zinc.—Tennessee continued to lead in zinc production, with output 34 percent more than in 1962 and 5 percent more than in 1960, the record year.

American Zinc Co. of Tennessee operated the Young, Coy, and Grasselli mines in Jefferson County and the Mascot No. 2 mine in Knox County. New Jeresy Zinc Co. operated the Jefferson City mine in Jefferson County. Tennessee Coal & Iron operated the Zinc Mine Works in Jefferson County. Tennessee Copper Co. recovered zinc concentrate from copper-zinc ores mined in Polk County. Total crude ore milled was 4,241,000 tons. New Market Zinc Co., a joint venture of American Zinc Co. of Tennessee, and Tri-State Zinc, Inc., completed sinking a circular shaft 1800 feet deep in Jefferson County. Planned production of 2,400 tons per day will begin in July, 1964. The concentrator will continue to treat ores from the American Zinc Co. Young Mine. New Jersey Zinc conducted development at its Flat Gap mine, closed since 1961, with plans to resume production of 2,000 tons per day early in 1964. American Zinc Co. was sinking two shafts, one to develop its Immel mine and the other to reopen its North Friends Station mine, closed since 1957. The Immel mine is scheduled for production of 2,000 tons per day by 1967; the North Friends Station mine, 500 tons per day by late 1964.

Exploration and development at zinc and copper mines included the following: Diamond drilling, 32,106 feet; percussion drilling, 68,641; drifting, 29,192; raising, 5,272 feet; winzing, 483 feet; shaft sinking, 690 feet; inclining, 478 feet; and long-hole drilling, 5,222 feet.

TABLE 12.—Mine production of recoverable gold, silver, copper, lead, and zinc

Year	Gold		Silver		Copper	
	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Short tons	Value (thousands)
1954–58 (average)	185	$7	58,251	$53	9,669	$6,464
1959	99	3	59,739	54	11,490	7,055
1960	123	4	64,560	58	12,723	8,168
1961	152	5	83,417	77	12,272	7,363
1962	158	6	112,251	122	14,298	8,808
1963	137	5	107,913	138	13,717	8,450
1831–1963	24,319	594	4,078,596	3,115	547,095	202,924

	Lead		Zinc		Total
	Short tons	Value (thousands)	Short tons	Value (thousands)	Value (thousands)
1954–58 (average)	1	(1)	46,752	$10,917	$17,441
1959	----	----	89,932	20,684	27,796
1960	----	----	91,394	23,580	31,810
1961	----	----	81,734	18,799	26,244
1962	51	$9	71,548	16,456	25,401
1963	----	----	95,847	22,045	30,638
1831–1963	27,143	3,185	1,692,861	344,426	554,244

[1] Less than $500.

REVIEW BY COUNTIES

Mineral production was reported from 79 counties; leading producers were Jefferson, Knox, Polk, Maury, and Davidson. In addition to the commodities listed in table 13, small quantities of oil and gas were produced; the county origin of these was undetermined.

Anderson.—Pocahontas Fuel Co. (Morco Colliery), Windrock Coal & Coke Co. (Windrock No. 2 mine), and Tennco, Inc. (No. 1 Strip mine) were the leading producers of the 39 active coal mines. Ralph Rogers & Co., Inc., (Oak Ridge quarry) and Anderson County Highway Department (Taylor's quarry No. 1) crushed limestone for concreate, roads, and stone sand. Lalite Corp. (Briceville mine) mined miscellaneous clay for lightweight aggregates.

Bedford.—A. R. Stone Co., Inc. (Shelbyville quarry) crushed limestone for concrete, roads, and agricultural stone (agstone). Several individuals reported collecting small quantities of gem stones (agate, quartz, and fossils).

Benton.—Four mines produced sand for glass, molding, and grinding and polishing; the leading producer was Hardy Sand Co. (Camden and Silica mines). Camden Gravel Co. and Memphis Stone & Gravel Co. mined gravel for paving.

Bledsoe.—C R & B Coal Co. (C R & B strip mine), Graysville Coal Co. (No. 1 mine), and A & S Coal Co. (No. 5 mine) were the leading producers of the six active coal mines.

Blount.—Gray Knox Marble Co. (Brown quarry), John J. Craig Co. (Marmor, Crisp, Lee, and Hamil quarries), and Tennessee Marble Co. (Endsley quarry) quarried dimension marble for rough and

TABLE 13.—Value of mineral production in Tennessee, by counties [1]

County	1962	1963	Minerals produced in 1963 in order of value [2]
Anderson	(3)	(3)	Coal, limestone, miscellaneous clay.
Bedford	(3)	(3)	Limestone, gem stones.
Benton	$1,222,594	$1,282,008	Sand and gravel.
Bledsoe	72,419	188,197	Coal.
Blount	(3)	(3)	Marble, limestone, iron ore.
Bradley	(3)	(3)	Limestone, sand and gravel.
Campbell	(3)	(3)	Coal, limestone, sandstone.
Cannon	(3)	(3)	Limestone, gem stones.
Carroll	(3)	(3)	Sand and gravel.
Carter	(3)	(3)	Limestone.
Claiborne	(3)	1,431,483	Coal, limestone.
Clay	(3)	131,000	Limestone.
Cocke	50,000	87,627	Do.
Coffee	(3)	(3)	Limestone, gem stones.
Cumberland	1,804,915	(3)	Sandstone, limestone, coal, sand and gravel.
Davidson	11,042,515	9,400,339	Cement, limestone, sand and gravel, phosphate rock, lime, miscellaneous clay.
Decatur	(3)	(3)	Limestone, sand and gravel.
De Kalb	31,879	----	
Dickson	----	(3)	Limestone.
Fayette	----	107,000	Sand and gravel.
Fentress	456,312	488,903	Coal, limestone, sandstone.
Franklin	(3)	(3)	Cement, limestone, sandstone, sand and gravel, miscellaneous clay.
Gibson	----	(3)	Sand and gravel.
Giles	(3)	(3)	Phosphate rock, limestone, sand and gravel.
Grainger	43,244	(3)	Marble, limestone.
Greene	(3)	(3)	Limestone.
Grundy	1,022,075	1,197,725	Coal, sand and gravel, limestone, gem stones.
Hamblen	(3)	462,144	Limestone.
Hamilton	7,957,159	8,085,219	Cement, limestone, sand and gravel, coal, miscellaneous clay.
Hardeman	(3)	67,500	Sand and gravel.
Hardin	(3)	(3)	Limestone.
Hawkins	(3)	198,941	Do.
Haywood	54,000	45,900	Sand and gravel.
Henderson	(3)	(3)	Do.
Henry	(3)	(3)	Ball clay, fuller's earth.
Hickman	(3)	(3)	Phosphate rock, limestone.
Humphreys	(3)	(3)	Limestone, sand and gravel.
Jefferson	(3)	(3)	Zinc ore, limestone.
Johnson	(3)	(3)	Limestone.
Knox	18,756,087	17,351,374	Cement, limestone, zinc, lime, marble, sand and gravel, miscellaneous clay.
Lauderdale	54,872	60,300	Sand and gravel.
Lawrence	(3)	----	
Lincoln	(3)	(3)	Limestone, gem stones.
Loudon	(3)	(3)	Barite, sand and gravel, miscellaneous clay, limestone.
Macon	115,000	100,000	Limestone.
Marion	(3)	(3)	Cement, limestone, coal.
Marshall	(3)	(3)	Limestone.
Maury	(3)	(3)	Phosphate rock, limestone.
McMinn	(3)	(3)	Limestone, barite.
McNairy	(3)	(3)	Sand and gravel.
Meigs	(3)	(3)	Limestone.
Monroe	(3)	(3)	Limestone, sand and gravel.
Montgomery	595,957	(3)	Limestone.
Morgan	(3)	1,176,010	Coal.
Obion	45,553	(3)	Sand and gravel.
Overton	(3)	(3)	Coal, limestone.
Pickett	60,959	40,726	Limestone, coal.
Polk	(3)	(3)	Copper, pyrites, zinc, silver, sand and gravel, gold, gem stones.
Putnam	(3)	(3)	Coal, limestone, sand and gravel.
Rhea	(3)	(3)	Limestone, coal.
Roane	(3)	454,244	Limestone.
Robertson	(3)	(3)	Do.
Rutherford	(3)	(3)	Do.
Scott	1,485,370	1,737,291	Coal.
Sequatchie	(3)	(3)	Coal, limestone, sandstone.
Sevier	(3)	(3)	Limestone, sand and gravel.
Shelby	1,413,726	(3)	Sand and gravel, miscellaneous clay.
Stewart	(3)	(3)	Sand and gravel.
Sullivan	(3)	(3)	Cement, limestone, miscellaneous clay.
Sumner	439,238	(3)	Phosphate rock, limestone.
Tipton	264,066	(3)	Sand and gravel.
Unicoi	(3)	614,567	Sand and gravel, limestone.
Union	(3)	(3)	Marble, limestone.
Van Buren	793,488	886,246	Coal.

See footnotes at end of table.

TABLE 13.—Value of mineral production in Tennessee, by counties [1]—Continued

County	1962	1963	Minerals produced in 1963 in order of value [2]
Warren	(3)	(3)	Limestone.
Washington	(3)	(3)	Limestone, miscellaneous clay.
Wayne	(3)	(3)	Limestone, sand and gravel.
Weakley	(3)	$2,336,956	Ball clay.
White	$328,920	317,537	Limestone.
Williamson	(3)	(3)	Phosphate rock, limestone.
Wilson	(3)	(3)	Limestone.
Undistributed [4]	[5] 105,908,652	112,473,763	
Total	[5] 154,019,000	160,723,000	

[1] The following counties are not listed because no production was reported: Cheatham, Chester, Crockett, Dyer, Hancock, Houston, Jackson, Lake, Lewis, Madison, Moore, Perry, Smith, and Trousdale.
[2] Petroleum and natural gas value is not listed by counties as data not available; value included with "Undistributed."
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Includes value of petroleum, natural gas, and values indicated by footnote 3.
[5] Revised figure.

dressed building stone and rough monumental stone. John J. Craig Co. and Tennessee Marble Co. crushed marble for terrazzo and other uses. Lambert Bros. Division of Vulcan Materials Co. (Maryville quarry) crushed limestone for concrete and roads. Big Flag Springs Mining Co. (Wilson mine) mined brown iron ore.

Bradley.—Bradley Limestone Co., Inc. (Welch quarry) and Bradley County Highway Department crushed limestone for concrete, roads, and agstone. Hiwassee Sand Co., Inc. mined sand for structural and paving uses.

Campbell.—Fifty-eight mines produced coal; the leading producers were Cox Coal Co. (No. 3 strip mine), Dixie Pine Coal Co., Inc. (No. 1 strip mine), and Hurricane Mountain Coal Co. (No. 2 mine). Key Limestone (LaFollette quarry) and Jellico Stone Co., Inc. (Jellico quarry) crushed limestone for concrete, roads, agstone, stone sand, and filter beds. White Silica Sand Co. (Silica quarry) crushed sandstone for concrete, roads, abrasives, and other uses.

Cannon.—Woodbury Stone Co. (Norvell quarry) crushed limestone for concrete and roads. Mrs. Walker Ledford and W. J. Martin collected small quantities of gem stones (geodes and quartz).

Carroll.—Hardy Sand Co. (Bruceton mine) mined sand for grinding and polishing and fertilizer filler.

Carter.—Watauga Stone Co. (Watauga quarry) crushed limestone for concrete, roads, railroad ballast, and stone sand.

Claiborne.—Acorn Coal Co. (No. 2 strip and No. 2 auger mines) and Harris Branch Coal Co. (No. 1 mine) were the leading producers of the 21 active coal mines. Lambert Bros. (Tazewell quarry) crushed limestone for concrete and roads.

Clay.—Dixie Limestone Co. (Celina quarry) crushed limestone for concrete, roads, and agstone. Nine oil wells totaling 5,137 feet were drilled.

Cocke.—Cocke County Highway Department (Smith quarry) crushed limestone for concrete and roads.

Coffee.—Ralph Rogers & Co., Inc. (Coffee County quarry) and Coffee County Highway Department (Winton quarry) crushed limestone for concrete, roads, and agstone. Virgil Owens collected a small quantity of gem stones (agate).

Cumberland.—Ten companies quarried dimension sandstone for rough architectural, sawed and dressed building stone, and flagging. The leading producers were Tennessee Stone Co., Inc. (McGuire quarry); Crab Orchard Stone Co., Inc. (Peck quarry); and Turner Bros. Stone Co., Inc. Turner Bros. Stone Co., Inc. crushed standstone for refractory use. Southern States Lime Corp. (Crab Orchard mine) and Cumberland County Highway Department (County quarry) produced limestone for riprap, fluxing stone, concrete, roads, railroad ballast, agstone, glass, paper, rock dust for coal mines, mineral food, and other uses. Five mines produced coal; the leading producer was Clear Creek Coal Co. (No. 1–A mine). Potter Sand & Gravel Co. (Crossville mine) mined sand and gravel for structural and paving uses.

Davidson.—Davidson County ranked fifth in the State in total value of mineral production. Marquette Cement Manufacturing Co. produced masonry and portland cements at the Nashville mill throughout the year. Lambert Bros. (Hermitage, Danley, and River Road quarries); Menifee Crushed Stone Co. (Nashville quarry); Hoover, Inc.; and Ellis & Alson Crushed Stone Co., Inc (E & O quarry) crushed limestone for concrete, roads, agstone, asphalt filler, and fertilizer filler.

Ingram Materials, Inc. (Nashville mine) mined sand and gravel for structural and paving uses. Monsanto Chemical Co. mined phosphate rock. Stauffer Chemical Co. produced lime for industrial uses. W. G. Bush & Co., Inc. (Nashville mine) mined miscellaneous clay for use in heavy clay products and cement. Tennessee Products & Chemical Corp. expanded crude perlite from Western States at the Nashville plant.

Decatur.—Western Materials, Inc. (Parsons quarry) produced limestone for riprap, concrete, roads, and agstone. Teague Bros. Sand & Gravel Co. and Tinker Sand & Gravel Co. mined sand and gravel for structural use.

Dickson.—Hoover, Inc. (Dickson quarry) crushed limestone for concrete and roads. Two oil wells totaling 2,765 feet were drilled.

Fayette.—Fayette County Highway Department (County mine) mined paving sand and gravel. One oil well totaling 2,220 feet was drilled.

Fentress.—Big Hurricane Coal Co. (Muddy Pond mine), Sells & Gibson Coal Co. (P. No. 2 mine), and Fentress County Coal Co. (Wilder mine) were leading producers of the 11 active coal mines. Frogge & Williams, Inc. (Wright quarry) crushed limestone for concrete, roads, and agstone. Crossville Stone Co. (Jamestown quarry) quarried dimension sandstone for rough architectural stone. One oil well totaling 800 feet was drilled.

Franklin.—Marquette Cement Mfg. Co. produced masonry and portland cements at the Cowan mill throughout the year. Cowan Stone Co. (Cowan quarry and Anderson mine), Marquette Cement Manufacturing Co. and Franklin County Highway Department (Bostick quarry) crushed limestone for concrete, roads, fluxing stone, agstone, cement, and other uses. Sewanee Silica Co. (Monteagle quarry) crushed sandstone for concrete, roads, abrasives, foundry, glass, pottery, filter, and other uses. Estill Springs Sand-Gravel Co. (Estill Springs mine) mined sand for structural and paving uses, and paving

gravel. Marquette Cement Manufacturing Co. (Cowan mine) mined miscellaneous clay for use in cement manufacture.

Gibson.—Hadley Construction Co., Inc. (Humboldt mine) mined paving sand and gravel.

Giles.—Monsanto Chemical Co. mined phosphate rock. Cedar Grove Lime Co. (Cedar Grove quarry) crushed limestone for concrete, roads, and agstone. Giles County Highway Department mined paving gravel.

Grainger.—Imperial Black Marble Corp. quarried dimension marble for rough building stone at the Thornhill quarry. Grainger County Highway Department crushed limestone for concrete and roads at the Mitchell quarry.

Greene.—Agricultural Lime Co., Inc. (Greenville quarry), Malone Bros. Quarry, Inc.; and Greene County Highway Department (Midway, Dog Walk, and Cove Creek quarries) produced limestone for riprap, concrete, roads, and agstone.

Grundy.—Ramsey Coal Co. (No. 1 strip mine) and Phipps & Sons Coal Co. (Commando strip mine) were the active coal producers. Cumberland Mountain Sand Co. (McMinnville mine) mined structural and paving sand. Viola White Lime Co. (Old State quarry) crushed limestone for concrete, roads, and agstone. Virgil Owens collected a small quantity of gem stones (agate).

Hamblen.—White Pine Stone Co. (Hamblen quarry) crushed limestone for concrete and roads.

Hamilton.—Signal Mountain Portland Cement produced masonry and portland cements at the Signal Mountain mill throughout the year. Chattanooga Rock Products (Chattanooga quarry) crushed limestone for concrete, roads, and agstone. Dixie Sand & Gravel Corp. (Dixie mine) mined sand and gravel for structural, paving, fill, and other uses. Seven mines produced coal; the leading producers were Russell Mining Co. (No. 7 strip mine) and Leon Patton Coal Co. (Millsap mine). General Shale Products Co. (Chattanooga mine) and Federal Ceramic Corp. (Daisy mine) mined miscellaneous clay for heavy clay products.

Hardeman.—Marcel Baudre (Saulsbury mine), Bolivar Sand Co. (Bolivar mine), and Tri-State Sand Co. mined structural sand.

Hardin.—Hardin Limestone Co. crushed limestone for concrete, roads, and agstone. Tennessee River Pulp & Paper Co. reclaimed lime for industrial uses.

Hawkins.—Lambert Bros. (McCloud quarry) crushed limestone for concrete and roads.

Haywood.—Haywood County Highway Department (County mine) mined paving gravel.

Henderson.—Ayers Mineral Co. (Zane mine) mined molding sand.

Henry.—H. C. Spinks Clay Co., Inc., Kentucky-Tennessee Clay Co., and Laird Brick Co. mined ball clay for whiteware, floor and wall tile, refractories, heavy clay products, and exports. Southern Clay Co., Inc. and Tennessee Absorbant Clay Co. mined fuller's earth for absorbent uses.

Hickman.—M. C. Boyle Phosphate Co. (Bratton mine) mined phosphate rock for agricultural uses. Cane Creek Limestone Co. (Hohen-

wald quarry) quarried limestone for riprap, concrete, roads, and agstone.

Humphreys.—Lambert Bros. (Rock Hill quarry) crushed limestone for concrete, roads, and railroad ballast. Sangravel Co., Inc. (Johnsonville mine) mined sand and gravel for structural and paving uses.

Jackson.—One oil well totaling 400 feet was drilled.

Jefferson.—Jefferson County ranked first in the State in total value of mineral production. American Zinc Co. of Tennessee (Young, Coy, and Grasselli mines), New Jersey Zinc Co. (Jefferson City mine), and Tennessee Coal & Iron (Zinc Mine Works) recovered zinc ores. Limestone was produced by the Jefferson County Highway Department and also recovered as a byproduct from zinc mines; this material was used for concrete, roads, railroad ballast, agstone, and stone sand.

Johnson.—Maymead Lime Co., Inc. (Dowell quarry) crushed limestone for concrete and roads.

Knox.—Knox County ranked second in the State in total value of mineral production. Ideal Cement Co. produced masonry and portland cements at the Knoxville mill throughout the year. American Zinc Co. of Tennessee (Mascot No. 2 mine) mined zinc ore and recovered limestone as a byproduct. Nine quarries and one mine produced limestone for riprap, concrete, roads, cement, lime, and other uses; leading producers were Lambert Bros. (City, Dixie Lee, Halls, and Lamon quarries) and Ideal Cement Co. (Knoxville quarry). Foote Mineral Co. and Williams Lime Mfg. Co. produced lime for construction, chemical, and industrial uses.

Gray Knox Marble Co. (Gray Knox quarry), Tennessee Marble Co. (Eagle quarry), and Appalachian Marble Co. (Bond and Appalachian quarries) quarried dimension marble for rough and dressed building stone and dressed monumental stone. Knoxville Crushed Stone Co. (Stone Road quarry) and Applachian Marble Co. crushed marble for terrazzo and other uses. Knoxville Sand & Gravel Co. (Knoxville mine) and Oliver King Sand & Lime Co., Inc. (King mine) mined sand and gravel for structural, paving, grinding and polishing, and engine uses. Shalite Corp., General Shale Products Corp., and Ideal Cement Co. mined miscellaneous clay for lightweight aggregates, heavy clay products, and cement.

Lauderdale.—Lauderdale County Highway Department mined paving gravel.

Lincoln.—Clark & Stephenson (Fayetteville quarry) and Lincoln County Highway Department crushed limestone for concrete, roads, and agstone. David Corn collected a small quantity of gem stones (agate).

Loudon.—B. C. Wood mined barite at the Cedar Fork mine. Lambert Bros. mined paving sand. Old Hickory Brick Co., Inc. (Greenback mine) mined miscellaneous clay for heavy clay products. Loudon County Highway Department (Greenway quarry) crushed limestone for concrete and roads.

Macon.—Dixon-Stubblefield Limestone Co. (Hillsdale quarry) crushed limestone for concrete and roads. One oil well totaling 700 feet was drilled.

Marion.—Penn-Dixie Cement Corp. produced portland cement at the Richard City mill throughout the year. Signal Mountain Portland

Cement (Bennetts Lake quarry), Penn-Dixie Cement Corp. (Richard City quarry), and Chattanooga Rock Products (Marion quarry) crushed limestone for concrete, roads, agstone, and cement. Twenty-seven mines produced coal; leading producers were Fred Walt Coal Co. (No. 2 strip mine), W. P. Church Coal Co. (No. 3 strip mine), and Grundy Mining Co. (Grays Creek No. 11 mine).

Marshall.—Lewisburg Limestone Co. (Lewisburg quarry) crushed limestone for concrete, roads, and agstone.

Maury.—Maury County ranked fourth in the State in total value of mineral production. Six operators produced phosphate rock; leading producers were Monsanto Chemical Co. (Monsanto mine) and Victor Chemical Works (Globe mine). Columbia Rock Products Corp. (Theta Pike mine) crushed limestone for concrete, roads, agstone, stone sand, and other uses. National Carbon Co. manufactured carbon and graphite products at the Columbia plant.

McMinn.—Floyd D. Webb Stone Co. (Webb quarry) and McMinn County Highway Department (Athens quarry) crushed limestone for concrete and roads. National Lead Co. (Ballard mine), Godsey Mines, Inc. (Calhoun and Athens mines), and Carl Richesin Mining Co. (Niota mine) mined barite. Bowaters Southern Paper Corp. reclaimed lime for industrial uses.

McNairy.—Worsham Bros. mined sand and gravel for structural, paving, and other uses.

Meigs.—Ten Mile Stone Co., Inc. (Ten Mile quarry) and Meigs Stone Co. (Posey quarry) quarried limestone for riprap, concrete, roads, and agstone.

Monroe.—Creighead Limestone Co. (Creighead quarry) and Monroe County Highway Department (Madisonville quarry) crushed limestone for concrete, roads, and agstone. Vonore Sand Co. and Tennessee River Sand Co. mined structural and paving sand. National Lead Co. shipped barite from stocks at the Roy mine.

Montgomery.—Simpson Stone Co. (Simpson quarry) and Clarksville Stone Co. (Clarksville mine) crushed limestone for concrete, roads, and agstone.

Morgan.—Eighteen mines produced coal; leading producers were G & F Coal Co., Inc. (G & F strip mine); Brushy Mountain Coal Mines (No. 7 mine); and W. R. Brooks Coal Co. (Mossy Grove strip mine). One oil well totaling 1,600 feet was drilled.

Obion.—Pioneer Materials, Inc. (Troy mine) and Obion County Highway Department mined sand and gravel for structural, paving, and fill uses.

Overton.—Thirteen mines produced coal; leading producers were Key & Hodge Coal Co. (Baker 8 mine) and Three Brothers Coal Co. (No. 1 mine). Livingston Limestone Co. crushed limestone for concrete, roads, and agstone at the East and South quarries. Two oil wells totaling 4,712 feet were drilled.

Pickett.—M & G Coal Co. (Koger mine) was the only active coal producer. Pickett County Highway Department crushed limestone for concrete and roads. Three oil wells totaling 1,390 feet were drilled.

Polk.—Polk County ranked third in the State in total value of mineral production. Tennessee Copper Co. mined mixed sulfide ore at the Boyd, Calloway, Cherokee, Eureka, and Mary mines. The ore was

concentrated at the Loudon flotation mill and yielded copper, iron (pyrite), lead, and zinc concentrates; gold and silver were recovered as byproducts from smelting the copper concentrates; the iron concentrate was roasted, yielding sulfur dioxide, which was used mainly in manufacturing sulfuric acid, and iron oxide, which was sintered for use by iron and steel plants. Campbell Sand & Gravel Co. (Isabella mine) mined sand for structural and fire or furnace use and gravel for miscellaneous uses. Carl Fox, Jr., and Tommy Hughes collected small quantities of gem stones (pyrite and chalcopyrite).

Putnam.—Clinchfield Coal Co. (Meadow Creek mine) was the only active coal producer. R. E. Poteet (Poteet quarry) and Putnam County Highway Department (Putnam quarry) crushed limestone for concrete, roads, and agstone. Sand, Inc. (Monterey mine) mined structural and paving sand. One oil well totaling 310 feet was drilled.

Rhea.—Rocky Creek Coal Co. (R C No. 1 mine), Ted Gibbs Coal Co. (No. 6 mine), and Norris Coal Co. (No. 1–A mine) were the active coal producers. Rhea County Limestone Co. (Dayton quarry) crushed limestone for concrete and roads.

Roane.—A. B. Long Quarries, Inc. (Swan Pond quarry), Roane Limestone Co., and Lambert Bros. crushed limestone for concrete, roads, railroad ballast, agstone, and stone sand. Tennessee Products & Chemical Corp. produced pig iron and sinter at the Rockwood plant.

Robertson.—Porter Brown Limestone Co. (Springfield No. 1 quarry) crushed limestone for concrete, roads, and agstone.

Rutherford.—A & R Stone Co., Inc. (Murfreesboro quarry) crushed limestone for concrete, roads, and agstone.

Scott.—Twenty-eight mines produced coal; leading producers were B. R. Campbell & Son (No. 1 strip mine), Poor Mountain Coal Co. (No. 1 mine), and R & R Coal Co. (Dean strip mine).

Sequatchie.—Fifteen mines produced coal; leading producers were Waters Coal & Construction Corp. (No. 1 strip mine), Henry Coal Co. (No. 1 mine), and W. T. Hickey Coal Co. (No. 3 mine). Dunlap Stone Co. (Sequatchie quarry) crushed limestone for concrete, roads, and agstone. Frank Bass quarried dimension sandstone for sawed and dressed building stone.

Sevier.—Lambert Bros. (Sevierville quarry) and Sevier County Highway Department crushed limestone for concrete and roads. Hodges Sand & Soil Co. (Sevierville mine) mined structural and paving sand.

Shelby.—Five mines produced sand and gravel for structural, paving, fill, and other uses; leading producers were Cordova Sand & Gravel Co. and W. S. Jordan Gravel Co. John A. Denies Sons Co. mined miscellaneous clay for lightweight aggregates for heavy clay products. Union Carbide Olefins Co. reclaimed lime for industrial uses.

Stewart.—T. L. Herbert & Sons, Inc. (Dover mine) mined structural sand and gravel. One oil well totaling 900 feet was drilled.

Sullivan.—Penn-Dixie Cement Corp. produced masonry and portland cements at the Kingsport mill throughout the year. Lambert Bros. (New Kingsport quarry) and Limestone Products Corp. (Rockway quarry) crushed limestone for concrete and roads. General Shale Products Corp. and Penn-Dixie Cement Corp. mined miscellaneous

clay for use in heavy clay products and cement. The Mead Corp. reclaimed lime for industrial use.

Sumner.—Monsanto Chemical Co. mined phosphate rock. Ralph Rogers & Co., Inc. (Pilot Knox mine and Sumner County quarry) and Sumner County Highway Department crushed limestone for concrete, roads, and agstone. Six oil wells totaling 1,075 feet were drilled.

Tipton.—Clyde W. Owens Sand & Gravel Co. (Covington mine) and Tipton County Highway Department mined sand and gravel for structural and paving uses.

Unicoi.—Brooks Sand-Gravel (Erwin mine) mined structural sand and paving and railroad-ballast gravel. Unicoi County Highway Department (Rex Lewis quarry) crushed limestone for concrete and roads. Carolina-Southern Mining Co., Inc. ground mica for welding rods and joint cement at the Kingsport Mica Grinding plant. The Feldspar Corp. (Erwin Grinding plant) ground feldspar for pottery uses.

Union.—Tennessee Marble Co. (Luttrell No. 3 quarry) quarried dimension marble for rough and dressed building stone. Union County Highway Department (Luttrell and Welch quarries) crushed limestone for concrete and roads.

Van Buren.—Eleven mines produced coal; leading producers were Walden Ridge Coal Co. (Walden Ridge No. 1 strip mine), Ziegler Construction Co. (No. 1 strip mine), and C R & B Coal Co. (No. 11 strip mine).

Warren.—Warren Limestone Co. (Warren mine) crushed limestone for concrete, roads, and agstone.

Washington.—Washington County Highway Department (Boones Creek, Corby, Dillow, Taylor Bridge, and Washington quarries) crushed limestone for concrete and roads. General Shale Products Corp. mined miscellaneous clay for use in heavy clay products.

Wayne.—Universal Limestone Co. (Waynesboro quarry) crushed limestone for concrete, roads, and agstone. Hassell & Dowdy Sand & Gravel (Baker mine) mined structural sand and gravel.

Weakley.—United Clay Mines Corp. (No. 6 mine), Bell Clay Co. (Collins mine), and H. C. Spinks Clay Co., Inc. mined ball clay for whiteware, enameling, floor and wall tile, firebrick and block, and heavy clay products.

White.—Farmers Limestone Co., Sparta Limestone Co., and White County Highway Department crushed limestone for concrete, roads, and agstone.

Williamson.—Monsanto Chemical Co. mined phosphate rock. Lambert Bros. (Franklin and County quarries) and Williamson County Highway Department (Globe quarry) crushed limestone for concrete and roads.

Wilson.—Marquette Cement Mfg. Co. (Martha quarry) and Wilson County Rock Products, Inc. (Lebanon and No. 2 quarries) crushed limestone for cement, concrete, roads, and agstone.

The Mineral Industry of Texas

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and Bureau of Economic Geology, the University of Texas, for collecting information on all minerals except fuels.

By F. F. Netzeband [1] and Roselle Girard [2]

TEXAS, with an imposing $4.4 billion value of mineral production in 1963, led the Nation for the 29th consecutive year. The 1963 total value was 2 percent greater than the 1962 value. The State was the largest domestic producer of crude oil, natural gas, natural gas liquids, helium, sulfur, and magnesium metal. Substantial quantities of cement, clay, gypsum, iron ore, lime, salt, sand and gravel, and stone were produced. Minerals and mineral fuels were produced in 241 of the State's 254 counties; crude oil in 199 counties; natural gas in 195; natural gas liquids in 116; nonmetallic minerals in 165; and metallic minerals in 5.

TABLE 1.—Mineral production in Texas [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	26,204	$83,162	29,104	$92,734
Masonry—thousand 280-pound barrels	926	2,774	930	2,858
Clays [2]—thousand short tons	3,744	5,634	4,199	6,849
Gem stones	(3)	150	(3)	150
Gypsum—thousand short tons	1,120	3,956	1,099	3,999
Helium—thousand cubic feet	245,623	8,552	[4] 264,342	[4] 9,252
Lime—thousand short tons	1,047	11,999	1,131	13,026
Natural gas—million cubic feet	6,080,210	747,866	6,205,034	775,629
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	3,205,517	233,345	3,320,416	218,975
LP gases—do	5,012,291	189,382	5,366,831	169,695
Petroleum (crude)—thousand 42-gallon barrels	943,328	2,818,709	[5] 973,097	[5] 2,893,990
Salt—thousand short tons	5,553	19,485	5,965	22,355
Sand and gravel—do	30,076	33,097	33,256	36,311
Stone—do	38,067	48,988	43,142	54,007
Sulfur (Frasch-process)—thousand long tons	2,655	57,297	2,550	50,109
Talc and soapstone—short tons	73,635	387	72,658	368
Value of items that cannot be disclosed: asphalt (native), barite, bromine, clay (fuller's earth), coal (lignite), graphite, iron ore (usable), magnesium chloride (for metal), magnesium compounds (except for metal), pumice, sodium sulfate, and uranium ore	----------	58,774	----------	62,777
Total	----------	[6] 4,323,557	----------	4,413,084

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producer).
[2] Excludes certain clays, value included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Does not include 668,938,000 cubic feet of crude helium valued at $6,858,000 shipped to underground storage at Amarillo, Texas.
[5] Preliminary figure.
[6] Revised figure.

[1] Mining engineer, Bureau of Mines, Bartlesville, Okla.
[2] Geologist, Bureau of Economic Geology, the University of Texas, Austin, Tex.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$4,133,042	1958	$4,037,540
1953	4,160,254	1959	4,278,693
1954	4,091,874	1960	4,125,974
1955	4,374,173	1961	4,186,317
1956	4,593,395	1962	4,211,075
1957	4,448,354	1963	4,297,029

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

An important and varied metals-extractive industry in Texas comprised 17 installations: 2 alumina plants; 3 aluminum, 1 magnesium, and 1 manganese reduction works; 1 antimony, 1 copper, 1 lead, 1 tin, and 3 zinc smelters; 1 copper refinery; and 2 integrated steel mills with associated blast furnaces. Cadmium was recovered as a by-product of smelter dust collection, zinc was recovered at a fuming plant, and gold and silver were recovered from base metal residues.

The State's industrial and business economy advanced irregularly for the third consecutive year with all major sectors—mining, manufacturing, and services—participating in varying degrees. Industrial production rose 5 percent to a new record in 1963, according to the Federal Reserve Bank of Dallas. Mineral production increased 4 percent in 1963—in 1962 it rose 1 percent. Manufacturing output rose 6 percent with durable goods being responsible for the increase. Construction activity advanced to new record highs for the third consecutive year. Residential and public works sectors reported improvement while nonresidential activity declined.

A basic formula, long used by the Railroad Commission of Texas in setting individual oil well production quotas in new fields, was rejected by the Texas Supreme Court in an important decision. The major effect of the ruling should be wider spacing between oil wells in future developed oilfields. Previously, a property owner could apply for an exemption from the normal spacing pattern set for a new oilfield, regardless of how small his tract was.

The first crude helium produced by private industry under the Federal Helium Conservation program was injected into underground storage in the Cliffside reservoir on January 5, 1963. The crude helium was recovered at the Sherman plant of Phillips Petroleum Co.

Texas and domestic natural gas producers were developing a liquefied methane (LNG) industry to resolve a vexing problem of adequate natural gas supply for peak demands in major consuming areas. Public utilities, following Federal Power Commission approval and a Bureau of Mines report, gave LNG a safety rating equal to gasoline. In the East, Midwest, Southeast, and West there were LNG storage projects under study.

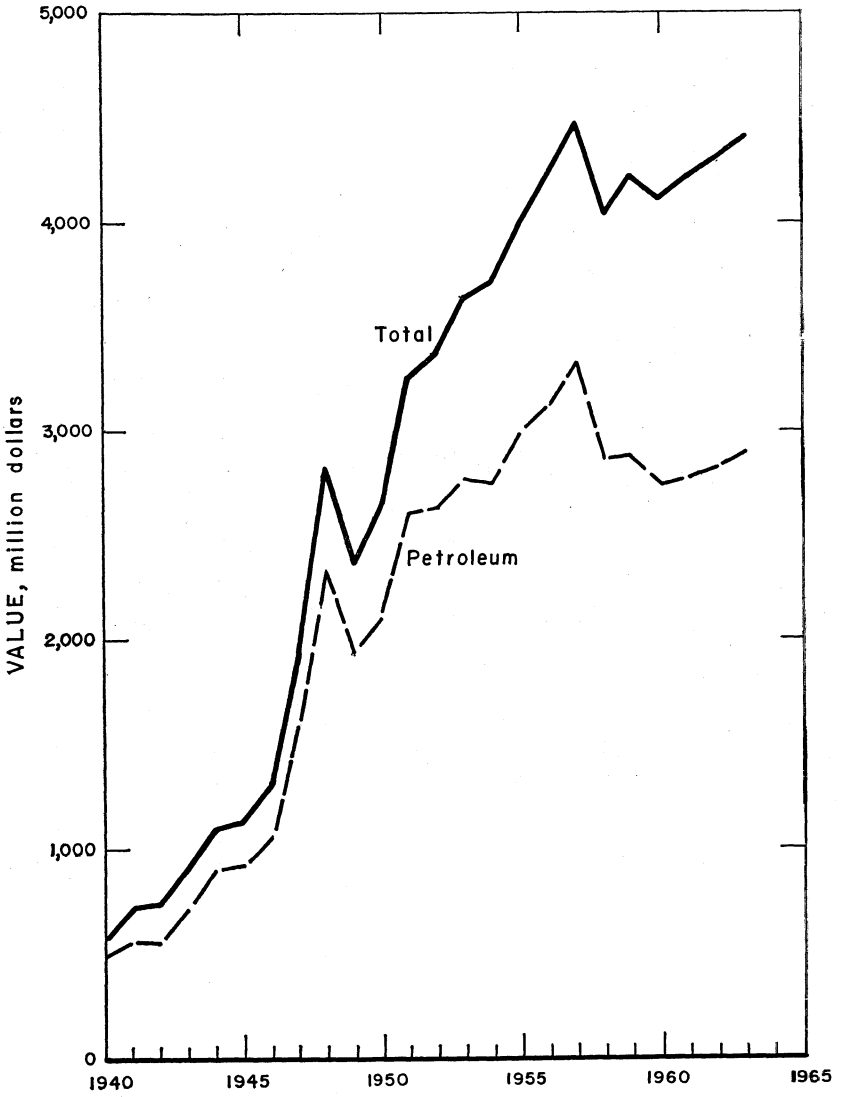


FIGURE 1.—Value of petroleum, and total value of mineral production in Texas, 1940–63.

Water remained an important mineral commodity with accelerated studies regarding its quality and reserves for industrial purposes and as a mode of transportation for ocean freight via the Intracoastal Waterway and for potential barge traffic via a number of its rivers entering the Gulf. The U.S. Army Corps of Engineers was implementing or had planned projects totaling $2 billion to extend waterways and improve existing ones over the next several years. Texas waterway projects planned or under construction included deepening the Houston Ship Channel from 30 to 40 feet, widening the Gulf

Intracoastal Waterway from 12 to 16 feet, enlarging the Victoria, Guadalupe and Colorado River channels for barge movements and enlarging the Matagorda Ship Channel. Late in December, the proposed $911 million Trinity River development program to permit barge traffic from the Gulf to the Fort Worth-Dallas area by dredging a 12-foot-deep, 150-foot-wide navigation barge channel, received Department of Commerce approval.

The Federal aerospace program continued its growing impact on the Texas industrial economy in 1963. Nearly $120 million was expended in construction contracts at the Manned Spacecraft Center (MSC) in the Houston area. The MSC also spent large sums for equipment, supplies, hardware, and services. There were about 3,000 employees at the Center in 1963.

Seven ammonia producing units with combined annual capacity of 400,000 tons were being built in 1963. Several other large units were in the planning stage. The new units included the 600-ton-per-day plant of American Oil Co. at Texas City, the 60-ton-per-day plant of Western Ammonia Corp. at Dimmit, the 166-ton-per-day Big Spring plant of W. R. Grace, the $20 million plant of Lone Star Producing Co. at Kerens, the 200,000-ton-per-year Plainview plant of Best Fertilizer Co., the $9 million Tenneco Co. plant at Houston, and the 70-ton-per-day plant of Odessa Natural Gasoline Co. at Odessa.

Texas remained one of the Nation's leaders in pertochemical output and capacity. The State was the major source of ethylene and acetic acid, both stock materials for many petrochemical intermediates and products.

A new electrolytic tin-smelting unit was installed at the Texas City plant of Wah Chang Corp. The new unit will permit processing of complex Bolivian tin ores, replacing Indonesian tin ores.

The State's three aluminum reduction plants operated at or near capacity in 1963 as metal demand increased.

Employment and Injuries.—Employment statistics compiled by the Texas Employment Commission, in cooperation with the Federal Bureau of Labor Statistics, are reported in table 3.

TABLE 3.—Employment data in mining and related industries

Industry	Employment		Weekly hours worked		Weekly earnings	
	1962 [1]	1963 [2]	1962	1963	1962	1963
Manufacturing	504,000	514,600	41.4	41.4	$96.05	$97.29
Primary metals	25,300	25,800	40.5	40.4	113.00	115.54
Stone, clay, and glass products	23,900	24,700	44.6	44.5	84.29	85.89
Chemicals	47,900	48,800	41.6	41.6	129.79	133.12
Petroleum and related industries	39,300	36,300	41.5	41.7	132.39	138.44
Transportation equipment	49,000	50,000	41.0	41.5	116.44	123.26
Nonmanufacturing	2,120,800	2,173,000				
Mining	117,700	113,100	42.4	42.6	114.48	118.00
Crude petroleum	[3] 111,500	[3] 106,700	42.3	42.5	116.33	119.85
Other mining	6,200	6,400	40.0	39.4	117.60	117.81
Construction	168,700	174,000				

[1] Revised figures.
[2] Preliminary figures.
[3] Includes natural gas.

Source: Texas Employment Commission in cooperation with U.S. Bureau of Labor Statistics.

Consumption, Trade, and Markets.—Because of the magnitude of mineral production in Texas, many of these industries were dependent upon national and international markets rather than intrastate markets. One of the major problems of the Texas economy has been the relatively slow development of consumer-oriented industries within the State. Among the major industries dependent upon national markets were petroleum refining, natural gas liquids extraction, natural gas distribution, nonferrous and light metal extractive industries, and bromine, graphite, natural salines, and sulfur.

A number of integrated industries converted raw materials into intermediates, finished products for both State and National markets, or processed raw materials from other States into products for additional manufacturing outside the State. Among such industries were oil refineries processing Texas and foreign crude oils; cement plants using local limestones, shell, and clays; and building material manufacturers using Texas gypsum to prepare wallboard, sheath, and plasters. The important petrochemical industry of the Gulf Coast produced the major portion of the domestic feedstocks—ethylene, propylene, and butylene—for numerous synthetic chemical products as plastics, fibers, solvents, etc. The feedstocks were derived from natural gas, natural gas liquids, and refinery off-gases. Over 200 chemical plants operated in Texas in 1963, producing nearly 500 chemicals, intermediates, and other synthetic products.

Legislation and Government Programs.—Several bills of interest to the mineral industries were enacted by the Legislature of Texas. Article 53–44–C permitted the School Land Board to extend the time of oil leases. Article 54–21–C–7, as amended, increased the size of tracts offered for lease for "hard" minerals from 20 acres to 640 acres. A Free Port bill exempted goods in interstate movement from ad valorem tax. Another bill extended a 7-year tax moratorium on special industrial sites from property taxes. A 7-year renewal option was included.

Water.—Water remained a prerequisite to continued development of the State's tremendous reserves of natural resources and for maintaining its industrial economic growth.

Water problems including long-range supply, quality, pollution, reuse, and treatment received increasing attention from Federal and State agencies and private research institutions. The Bureau of Mines conducted a nationwide canvass of the mineral industry to obtain 1962 water use data. The following tables are based on results of the survey.

TABLE 4.—Water use in the mineral industry in 1962

(Million gallons)

	New water	Water recirculated	Total water use	Water discharged	Water consumed
Quarries and mills	563	2,132	2,695	273	290
Metal mines and mills	465	1,737	2,202	154	311
Nonmetal mines and mills	13,772	97	13,869	9,696	4,076
Sand and gravel mines	22,626	10,903	33,529	21,499	1,127
Natural gas processing plants	28,645	906,330	934,975	6,851	21,794
Petroleum	40,109	14,856	54,965	1,811	38,298
Total	106,180	936,055	1,042,235	40,284	65,896

TABLE 5.—Water usage of wells drilled by cable tools, by counties, in 1962

(Barrels)

County	Number of wells	Total footage	Fresh water used	Saline water used	Other water used	Total barrels per foot
Bell	1	1,022	500			.49
Bexar	62	62,351	15,200	16,000		.50
Burnet	1	1,450	700			.48
Callahan	1	2,000	500			.25
Crockett	1	2,000	600			.30
Falls	6	5,499	2,750			.50
Hays	1	913	450			.49
Palo Pinto	1	3,500	250	1,000		.36
Pecos	5	9,200	3,000			.33
Reeves	7	21,678			7,000	.32
Ward	1	363	500			1.38
Washington	6	3,687	1,800			.49
Williamson	1	1,000	500			.50
Winkler	2	285	200			.70
Total	96	114,948	26,950	17,000	7,000	.44

TABLE 6.—Water usage of wells drilled by rotary tools, by counties, in 1962

(Barrels)

County	Number of wells	Total footage	Fresh water used	Saline water used	Other water used	Total barrels per foot
Anderson	76	477,793	717,350			1.50
Andrews	196	1,587,181	2,912,753	533,020		2.17
Angelina	4	13,818	13,800			1.00
Aransas	15	94,820	90,725			.96
Archer	575	991,265	773,034			.78
Atascosa	44	158,104	97,800			.62
Austin	6	49,850	39,900			.80
Bastrop	23	43,658	35,000			.80
Baylor	65	123,634	111,597			.90
Bee	75	403,263	273,574			.68
Borden	27	224,040	295,686			1.32
Bowie	4	24,185	48,300			2.00
Brazoria	97	747,453	1,832,900			2.45
Brazos	1	12,800	6,500			.51
Brewster	2	8,129	24,400			3.00
Brooks	89	701,439	2,455,665			3.50
Brown	44	84,828	151,650	5,000		1.85
Burleson	1	3,808	3,800			1.00
Caldwell	183	466,669	373,300			.80
Calhoun	62	581,285	592,500			1.02
Callahan	206	287,231	192,900			.67
Cameron	13	113,083	209,351			1.85
Camp	7	58,174	243,930			4.19
Carson	113	369,501	564,636			1.53
Cass	38	362,707	1,483,240	6,435		4.11
Castro	4	37,198	52,100			1.40
Chambers	110	903,782	807,200			.89
Cherokee	24	126,879	218,237	52,010		2.13
Childress	6	32,340	78,894			2.44
Clay	90	246,770	145,523			.59
Cochran	59	314,473	345,900			1.10
Coke	52	285,778	429,288			1.50
Coleman	134	294,695	196,900			.67
Collin	1	7,298	10,900			1.49
Collingsworth	18	36,856	55,280			1.50
Colorado	25	196,885	96,900			.49
Comanche	9	24,856	12,453			.50
Concho	48	186,039	197,136			1.06
Cooke	267	825,971	960,441		86,900	1.27
Cottle	4	21,524	58,100			2.70
Crane	367	1,703,134	4,520,802	1,166,050		3.34
Crockett	136	626,270	869,750			1.39
Crosby	11	72,955	58,100			.80
Culberson	32	104,253	64,099	1,000		.62
Dallam	2	9,600	16,200			1.69
Dawson	157	831,240	1,952,585	541,700		3.00
Deaf Smith	1	9,505	14,000			1.47
Delta	1	7,050	14,000			1.99

TABLE 6.—Water usage of wells drilled by rotary tools, by counties, in 1962—Con.

(Barrels)

County	Number of wells	Total footage	Fresh water used	Saline water used	Other water used	Total barrels per foot
Denton	16	58,846	66,372			1.13
De Witt	65	607,855	960,371			1.58
Dickens	3	20,723	78,900			3.81
Dimmit	15	50,533	75,800			1.50
Donley	2	9,022	13,533			1.50
Duval	233	933,136	304,608			.33
Eastland	40	129,867	129,865			1.00
Ector	219	1,416,989	1,952,928	524,865		1.75
Edwards	6	37,440	52,245			1.40
Ellis	1	1,900	1,900			1.00
Erath	21	73,909	106,850	27,430		1.84
Fannin	1	2,320	4,600			1.98
Fayette	10	61,260	50,160			.82
Fisher	134	569,697	733,582		28,681	1.34
Floyd	1	6,120	6,120			1.00
Foard	21	69,071	150,200			2.17
Fort Bend	50	248,771	243,700			.98
Franklin	31	154,546	386,400			2.50
Freestone	35	165,585	331,200			2.00
Frio	25	97,748	86,200			.88
Gaines	150	1,116,247	2,198,009	537,205		2.45
Galveston	124	915,053	1,432,700			1.57
Garza	81	311,382	296,229	23,140		1.03
Glasscock	13	77,016	121,266	17,234		1.80
Goliad	111	631,071	690,100			1.09
Gonzales	18	161,923	187,668			1.16
Gray	87	278,102	264,085			.95
Grayson	81	494,087	972,804	164,252		2.30
Gregg	17	120,526	241,000			2.00
Guadalupe	91	189,639	190,000			1.00
Hale	1	6,100	6,100			1.00
Hall	3	7,120	8,470			1.19
Hamilton	1	4,309	4,300			1.00
Hansford	91	610,727	768,774			1.26
Hardeman	30	210,709	348,500	44,400		1.86
Hardin	101	385,014	376,500			.98
Harris	109	480,224	586,200			1.22
Harrison	67	285,604	599,700			2.10
Haskell	67	313,525	343,413	115,540		1.46
Hemphill	31	291,552	1,201,000			4.12
Henderson	79	757,016	2,749,521	12,684		3.65
Hidalgo	53	463,842	1,800,000			3.88
Hill	4	5,375	5,400			1.00
Hockley	85	536,600	643,375			1.20
Hood	1	5,310	5,300			1.00
Hopkins	8	82,137	204,754			2.49
Houston	39	342,455	1,188,250			3.47
Howard	115	416,455	460,784	58,631		1.25
Hudspeth	1	7,060	80,000	5,000		12.04
Hunt	7	34,778	70,000			2.01
Hutchinson	265	785,112	1,019,896			1.30
Irion	17	55,061	76,906			1.40
Jack	179	580,421	1,280,734	119,915		2.41
Jackson	135	947,492	682,600			.72
Jasper	13	136,924	370,300			2.70
Jeff Davis	2	13,451	47,100			3.50
Jefferson	102	793,756	620,100			.78
Jim Hogg	81	373,215	736,700			1.97
Jim Wells	137	701,731	469,575			.67
Johnson	1	9,085	9,100			1.00
Jones	139	312,945	307,635			.98
Karnes	57	542,363	889,947			1.64
Kaufman	8	37,536	75,100			2.00
Kenedy	33	315,358	315,300			1.00
Kent	18	117,725	154,273			1.31
Kerr	1	2,869	5,740			2.00
Kimble	11	37,431	84,165			2.25
King	7	37,236	77,200	25,045		2.75
Kinney	11	20,573	30,850			1.50
Kleberg	197	1,486,279	1,928,782			1.30
Knox	51	101,586	110,949			1.09
Lamb	3	12,765	13,760			1.08
Lampasas	1	2,867	2,300			.80
LaSalle	19	92,484	81,600			.88
Lavaca	37	332,721	162,500			.49
Leon	86	643,995	1,804,060			2.80

TABLE 6.—Water usage of wells drilled by rotary tools, by counties, in 1962—Con.

(Barrels)

County	Number of wells	Total footage	Fresh water used	Saline water used	Other water used	Total barrels per foot
Liberty	104	524,456	518,400			.99
Limestone	26	120,172	180,250			1.50
Lipscomb	92	716,497	456,841			.64
Live Oak	102	599,578	420,804			.70
Loving	74	345,074	711,900			2.06
Lubbock	7	45,534	47,300			1.04
Lynn	12	66,839	73,500			1.10
McCulloch	3	3,996	3,200			.80
McLennan	3	3,227	1,600			.50
McMullen	79	353,089	278,950			.79
Madison	15	158,535	345,600			2.18
Marion	26	113,838	341,500			3.00
Martin	117	943,911	1,906,395	38,900		2.06
Matagorda	167	1,612,102	4,942,850			3.07
Maverick	84	69,815	139,600			2.00
Medina	134	235,261	57,300			.24
Menard	34	117,326	131,591			1.12
Midland	37	378,160	1,171,410	129,100		3.44
Milam	39	45,230	22,600			.50
Mills	1	2,710	2,710			1.00
Mitchell	68	248,226	297,811			1.20
Montague	123	609,988	1,157,375			1.90
Montgomery	10	66,947	246,400			3.68
Moore	66	203,196	246,020			1.21
Motley	8	47,675	69,750	37,000		2.24
Nacogdoches	5	24,859	24,900			1.00
Navarro	126	132,391	132,400			1.00
Newton	30	299,288	287,900			.96
Nolan	63	416,111	611,676			1.47
Nueces	162	1,138,870	1,231,971			1.08
Ochiltree	159	1,323,607	1,694,431			1.28
Oldham	1	3,987	5,980			1.50
Orange	32	252,078	248,400			.99
Palo Pinto	42	154,930	129,856	500		.84
Panola	143	592,823	352,888			.60
Parker	31	142,821	102,860			.72
Parmer	1	9,415	13,200			1.40
Pecos	182	927,423	3,845,714	878,914		5.09
Polk	12	118,712	119,000			1.00
Potter	16	38,149	57,217			1.50
Presidio	1	9,256	77,500			8.37
Rains	4	43,174	235,700			5.46
Reagan	72	368,608	420,760			1.14
Real	2	11,718	20,876			1.78
Red River	4	9,552	19,000			1.99
Reeves	109	515,060	1,538,068	320,455		3.61
Refugio	146	888,462	407,054			.46
Roberts	20	158,086	503,520	5,580		3.22
Robertson	1	3,300	4,950			1.50
Runnels	142	525,748	396,394		23,405	.80
Rusk	65	468,818	581,562			1.24
Sabine	7	35,348	102,750			2.91
San Augustine	5	32,430	32,400			1.00
San Jacinto	6	41,285	41,300			1.00
San Patricio	93	539,345	457,500			.85
Schleicher	51	259,034	389,273			1.50
Scurry	91	367,639	359,851	74,007		1.18
Shackelford	316	523,801	516,499	145,235	8,086	1.28
Shelby	13	61,405	61,400			1.00
Sherman	12	55,465	83,200			1.50
Smith	29	215,552	407,949			1.89
Starr	91	501,513	563,800			1.12
Stephens	91	316,719	396,158		8,372	1.28
Sterling	39	150,810	288,200	3,050		1.93
Stonewall	49	235,874	340,669		15,516	1.51
Sutton	12	61,704	77,108			1.25
Swisher	1	9,302	13,950			1.50
Taylor	179	656,336	746,116		7,793	1.15
Terrell	15	193,491	410,140	141,065		2.85
Terry	15	109,718	167,016			1.52
Throckmorton	180	437,434	581,302	155,797		1.69
Titus	31	136,679	341,700			2.50

TABLE 6.—Water usage of wells drilled by rotary tools, by counties, in 1962—Con.

(Barrels)

County	Number of wells	Total footage	Fresh water used	Saline water used	Other water used	Total barrels per foot
Tom Green	37	138,227	209,985			1.52
Travis	18	14,187	7,100			.50
Trinity	1	14,900	14,900			1.00
Tyler	6	61,050	61,000			1.00
Upshur	29	115,602	231,200			2.00
Upton	107	647,356	1,223,196	26,550		1.93
Uvalde	6	16,381	24,550			1.50
Val Verde	4	38,287	57,400			1.50
Van Zandt	12	95,858	252,100			2.63
Victoria	107	610,047	451,260			.74
Waller	4	44,080	44,000			1.00
Ward	222	1,095,090	2,648,835	1,425,900		3.72
Webb	83	342,135	985,180			2.88
Wharton	101	533,282	1,649,000			3.09
Wheeler	53	130,963	196,386			1.50
Wichita	583	933,573	1,199,111			1.28
Wilbarger	166	381,803	481,062	103,406		1.53
Willacy	8	68,391	75,233			1.10
Wilson	55	126,918	152,300			1.20
Winkler	226	902,400	1,219,033	192,047		1.56
Wise	150	837,810	851,652	114,715		1.15
Wood	22	181,038	793,100			4.38
Yoakum	92	628,608	603,014	31,934		1.01
Young	279	696,604	493,505	88,000		.83
Zapata	65	284,383	451,739			1.59
Zavala	100	352,770	525,600			1.49
Various	22	234,669	361,621	54,346		1.77
Total	14,616	68,318,370	108,332,664	7,947,057	178,753	1.70

TABLE 7.—Barrels of water injected by secondary recovery operations in 1962

Water source by geologic period	New water injected			Injected water produced from oil wells			Total water injected
	Fresh	Saline	Total	Fresh	Saline	Total	
Cambrian-Ordo		40,848,537	40,848,537		2,422,780	2,422,780	43,271,317
Silurian-Devonian					300,000	300,000	300,000
Mississippian	258,000	3,631,412	3,889,412				3,889,412
Pennsylvanian	4,481,351	125,711,731	130,193,082		162,737,380	162,737,380	292,930,462
Permian	14,164,006	209,036,763	223,200,769		125,202,051	125,202,051	348,402,820
Triassic	51,073,814	77,180,073	128,253,887				128,253,887
Cretaceous	33,801,003	16,304,107	50,105,110		16,320,521	16,320,521	66,425,631
Tertiary	20,918,353	68,676,266	89,594,619		46,718,898	46,718,898	136,313,517
Quaternary	74,515,095	1,440,543	75,955,638				75,955,638
Total	199,211,622	542,829,432	742,041,054		353,701,630	353,701,630	1,095,742,684
Surface water injected (part brackish)							96,430,743
Total water injected							1,192,173,427

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Texas remained the Nation's leading producer of crude oil, natural gas, and natural gas liquids. Petroleum production continued improvement for 3 consecutive years. The extent of its advance was limited by excessive stocks of many refined products. Average daily crude oil production at 2,666,020 barrels was 3 percent over that of 1962.

The Texas Railroad Commission's new percentage method for regulated oil wells was in operation in 1963. Prorated crude oil production was estimated to be about 3 percent greater. In 1962, Texas Oil producers were limited to 97 producing days compared with 103 producing days in 1963.

Supply and demand of crude oil and many of its refined products approached a more stable level. The industry was still faced with large inventories of gasoline, middle distillates, and crude oil. Continuation of mild fall weather lowered distillate demand in the mid-continent area, creating a troublesome supply situation and resulting in lower prices of crude oil, gasoline, and some other refined products.

TABLE 8.—Production trends of crude oil, natural gas, and natural gas liquids for select years

(Million barrels of oil equivalent)

Year	Production [1]				Percentage of—						
					Annual total			Change of reported year			
	Oil	Gas	Liquids	Total	Oil	Gas	Liquids	Oil	Gas	Liquids	Total
1940	493	190	16	699	70.5	27.1	2.4				
1950	830	558	69	1,457	57.0	38.3	4.7	68.4	193.7	331.3	108.4
1956	1,108	892	116	2,116	52.4	42.1	5.5	33.5	59.9	68.1	54.2
1960	927	1,052	128	2,107	44.0	49.9	6.1	−16.3	17.9	10.3	−0.4
1961	939	1,065	137	2,141	43.9	49.7	6.4	1.3	1.2	7.0	1.6
1962	943	1,086	143	2,172	43.4	50.0	6.6	0.4	2.0	4.4	1.4
1963	973	1,108	151	2,232	43.6	49.6	6.8	3.2	2.0	5.6	2.8

[1] One barrel of crude oil equivalent to 5,600 cubic feet of natural gas or 57.4 gallons of natural gas liquids, a composite of 52.7 gallons of natural gasoline and 60.8 gallons of LP gases.

A total of 2,936 exploratory wells were drilled by the oil and gas industry resulting in discovery of 348 oilfields and 209 gasfields. Multiple well completions are shown in table 11. Counties with the greatest number of new discoveries were Pecos 24, Duval and Runnels 16, Throckmorton 13, and Archer, San Patricio, Stephens, and Montague 11 each.

TABLE 9.—Comparison of mineral fuels production in Texas and the United States

Fuel	Production [1] as oil equivalent				Percent of fuels				Texas percent of United States		Percent change from 1962	
	Texas		United States		Texas		United States					
	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963	Texas	United States
Crude oil	943	973	2,676	2,753	43.4	43.6	49.3	48.5	35.2	35.3	+3.2	+2.9
Natural gas	1,086	1,108	2,478	2,633	50.0	49.6	45.7	46.4	43.8	32.1	+2.0	+6.3
Natural gas liquids	143	151	273	293	6.6	6.8	5.0	5.1	52.4	51.5	+5.6	+7.3
Total equivalent	2,172	2,232	5,427	5,679	100	100	100	100	40.0	39.3	+2.8	+4.6

[1] Million barrels of oil equivalent, derived by gas and liquids factors reported in table 8.

TABLE 10.—Fuels reserves ratio to production in Texas and the United States

Fuel	Reserves [1]				Percent—				Reserve ratio			
	Texas		United States		Texas of United States		Change from 1962		Texas		United States	
	1962	1963	1962	1963	1962	1963	Texas	United States	1962	1963	1962	1963
Crude oil	14,648	14,573	31,389	30,970	46.7	47.1	−0.5	−1.3	15.5	15.0	11.7	11.2
Natural gas	21,224	21,037	48,621	49,313	43.7	42.7	−0.9	+1.4	19.5	19.0	19.6	18.7
Natural gas liquids	2,802	2,958	5,350	5,615	52.4	52.7	+5.6	+5.0	19.6	19.6	19.6	19.2
Total oil equivalent	38,674	38,568	85,360	85,898	45.3	44.9	−0.3	+0.6	17.8	17.3	15.7	15.1

[1] Million barrels of oil equivalent, derived by gas and liquids factors reported in table 8.

TABLE 11.—Multiple well completions in 1963

Type	Oil		Gas		Combination	Combination		
	Zones	Wells	Zones	Wells		Oil	Gas	Wells
Dual	1,134	567	544	272	173			
Triple	414	138	135	45		89	79	56
Quadruple	92	23	44	11		31	37	17
Quintuple	10	2				2	3	1

Source: The Oil and Gas Journal.

The 1963 value of mineral fuels advanced 2 percent over the 1962 value, but was 3 percent under that of the record 1957 year. Crude oil represented 71 percent of the 1963 and 1962 fuels value, compared with 80 percent in 1957. The 1963 crude oil value was 3 percent greater than in 1962 but 13 percent less than in 1957. Natural gas accounted for 19 percent and natural gas liquids 10 percent of the 1963 fuels value. Crude oil prices have fluctuated downward from $3.11 per barrel in 1957, the record fuels year, to $2.97 in 1963. Conversely, natural gas advanced consistently in both output and unit price, averaging 9.7 cents per thousand cubic feet in 1957 compared with an estimated average of 12.5 cents per thousand cubic feet in 1963. Unit values of natural gas liquids declined slightly from 6.8 cents per gallon for natural gasoline in 1957 to 6.6 cents in 1963. Price of LP gases slumped to 3.2 cents per gallon, compared with 3.8 cents in 1962 and 3.9 cents in 1957.

The following analysis illustrates the reason for the relatively static position of the State's crude oil industry as compared with the expanding natural gas industry.

	Production [1]			Value [2]		
	1950	1963	Change	1950	1963	Change
Oil	830	973	145	2,147	2,895	748
Gas	558	1,096	538	147	761	614
Total	1,388	2,069	683	2,294	3,656	1,362

[1] Million barrels of crude oil with 1 barrel of oil equivalent to 5,600 cubic feet of natural gas.
[2] Million dollars.

With natural gas expressed in equivalent units (barrels) of crude oil to afford comparability, Texas natural gas production nearly doubled (from 558 to 1,096) in 1950–63, while crude oil output advanced less than 20 percent. The change in natural gas production was nearly four times greater than that of oil.

The world's deepest producing gas well, Pure Oil Co.'s 1 W. C. Tyrrell, 9 miles northwest of Fort Stockton in Pecos County. The record well flowed 19.9 million cubic feet per day through perforations between 19,871 to 19,895 feet, completed in the Ellenburger.

One of the State's oldest and most renowned gas cycling operations, the Opelika, in the prolific Rodessa reservoir, was closed at midyear. The cycling project, begun January 1, 1941, ultimately recovered 694 billion cubic feet of gas, 2 billion barrels of lease condensate, 16.8 billion barrels of gas liquids, and 7.2 billion barrels of crude oil.

TABLE 12.—Production and value of mineral fuels

Year	Crude petroleum		Natural gas [1]	
	Thousand barrels	Value (thousands)	Million cubic feet	Value (thousands)
1954–58 (average)	1,029,883	$3,019,911	4,923,241	$443,654
1959	971,978	2,893,146	5,718,993	617,651
1960	927,479	2,748,735	5,892,704	665,876
1961	939,191	2,791,377	5,963,605	733,523
1962	943,328	2,818,709	6,080,210	747,866
1963	[2] 973,097	2,893,990	6,205,034	775,629

Year	Natural gas liquids					
	Natural gasoline and cycle products		LP gas		Total	
	Thousand gallons	Value (thousands)	Thousand gallons	Value (thousands)	Thousand gallons	Value (thousands)
1954–58 (average)	2,900,097	$205,874	3,556,736	$130,117	6,456,833	$335,991
1959	2,790,155	209,238	4,353,368	181,148	7,143,523	390,386
1960	2,880,906	207,583	4,476,142	200,478	7,357,048	408,061
1961	3,111,427	214,279	4,768,222	185,558	7,879,649	399,837
1962	3,205,517	233,345	5,012,291	189,382	8,217,808	422,727
1963	3,320,416	218,975	5,366,831	169,695	8,687,247	388,670

[1] Marketed production, gas either sold or consumed by producers including losses in transmission, amount added to storage, and increases in gas pipelines.
[2] Preliminary figure.

Carbon Black.—Carbon black was recovered from sour natural gas and natural gas liquids at 21 plants in 14 counties. There were 7 channel plants, 13 furnace plants, and 1 combination channel-furnace plant. The plants consumed 76,750 million cubic feet of gas and 195 million gallons of hydrocarbon liquids in producing 1,105 million pounds of carbon black.

Coal (Lignite).—Lignite was produced in two counties—Milam and Harrison—by two producers; 1963 output was somewhat greater than 1962. Most of the lignite was used as fuel for electric power generation with substantial quantities processed for activated carbons.

Helium.—Phillips Petroleum Co. operated a $14 million plant 4 miles southeast of Dumas with a daily gas treating capacity of 275 million cubic feet to recover about 600 million cubic feet of helium a year from natural gases of Panhandle and Hugoton gasfields. Phillips also had an $11 million plant south of Guymon, Okla., in Hansford County, Tex., which could process 200 million cubic feet of gas daily from Panhandle and Hugoton gasfields to recover 450 million cubic feet of helium a year.

Under the Helium Conservation Program enacted by Congress in 1961, the Federal Bureau of Mines expects to recover 88 billion cubic feet of helium in the next 25 years.

Liquid helium was produced at the 125-liters-per-hour Amarillo plant of Linde, Division of Union Carbide. Production began about midyear 1962.

Natural Gas.—Texas continued to be the leading natural gas producing State in the Nation, with a record output of 6,205,034 million cubic feet, up 2 percent over the previous 1962 record. Of the 1963 output (including receipts), 3,313,837 million cubic feet was consumed in the State, 2,933,708 million cubic feet was exported, and 76,750 million cubic feet used in manufacturing carbon black. Principal gas producing counties in order of value were Brazoria, Winkler, Nueces, Moore, and Hidalgo. Natural gas reserves dipped nearly 1 percent to 117,809,376 million cubic feet, comprising 43 percent of total domestic reserves. Exploratory drilling added 2,796,001 million cubic feet to proved gas reserves; development drilling added 2,286,825 million cubic feet. There were 22,016 gas wells producing on December 31, 1963.

Industrial uses accounted for 39 percent of Texas consumption, field use 36 percent, refineries 13 percent, residential and commercial use 8 percent, and pipeline and carbon black the remainder.

A 4.4-million-cubic-foot gas processing plant to extract hydrogen sulfide and carbon dioxide from sour natural gas with hot potassium carbonate solution was built near Kenedy by Brown & Schiff, Inc.

Phillips Petroleum Co. completed two important gas wells. Upper Morrow production was confirmed with a daily gauge of 1.35 million cubic feet at its No. Bowers "A" in Hemphill County, and Ellenburger production of 5.16 million cubic feet at 16,802 to 16,900 was obtained at its No. 1 Carwile "A" near New Mobeetie, Wheeler County. Simpson production of 18.8 million cubic feet per day at 15,676 to 15,688 was also confirmed. The 1963 prices for natural gas purchased from pipelines within Texas were lower than in 1962—averaging about 17 cents per thousand cubic feet with large volume and long term contracts being settled as low as 15 cents per thousand cubic feet. Contract terms accounted for the decline.

Gas from the huge King Ranch reserve of Humble Oil & Refining Co. will be made available to Texas rather than out-of-State markets with completion of a 290-mile, 36- and 30-inch pipeline from the King Ranch cycle plant to the Houston industrial region. The line will make available 1.2 billion cubic feet of gas daily to the Houston industrial complex.

Lone Star Gas Co. developed gas storage capacity of 38.5 billion cubic feet in Tri-Cities reservoirs of Bacon and Rodessa limestones near Athens. Transmission facilities will permit deliveries of 300 million cubic feet daily to the company's transmission system at peak demand periods.

Natural Gas Liquids.—Texas was principal producer of natural gas liquids in 1963, supplying 52 percent of domestic output. Natural gasoline plants processed an average of 16,593 million cubic feet of gas daily to recover an average of 23.8 million gallons of liquids daily. Output in 1963 was 6 percent greater than that of 1962. LP gases accounted for 62 percent of the recovered liquids; natural gasoline and other cycle products accounted for the remaining 38 percent. There were 273 gasoline plants and 32 cycling plants operating in the State in 1963. Proved recoverable reserves of natural gas liquids amounted to 4,042 million barrels, according to the Committee on Natural Gas Reserves of the American Gas Association. Exploratory

drilling added 64 million barrels to proved reserves; development drilling added 416.4 million barrels.

Texas had the largest underground storage capacity for natural gas liquids in the Nation, totaling 57.4 million barrels in 1963, including 621,000-barrel capacity under development. Another 2-million-barrel storage cavern was planned for a Freestone County salt dome by Central Texas Underground Storage, Inc. Thirty-nine companies operated 105 underground facilities in 37 counties. The five largest caverns and their capacities in million barrels follow: Warren Petroleum Corp., Chambers County, salt dome, 10.3; Texas Eastern Transmission Corp., Chambers County, salt dome, 5.7; Phillips Petroleum Co., Hutchinson County, salt layer, 4.1; Brazoria County, salt dome, 3.7; and Tenneco Oil Co., Chambers County, salt dome, 2.8. Many of the underground storage units had from 3 to 13 caverns for each facility.

The natural gas liquids industry of the Nation, particularly that in Texas and Louisiana, faced a serious oversupply situation during most of 1963. Total national gas liquid stocks increased 8 percent, 33.7 million barrels over that of 1962. LP gas stocks rose 10 percent to 27.7 million barrels, accounting for over 90 percent of total liquids stock. Natural gasoline stocks, however, declined 3 percent to approximately 4 million barrels, from that of 1962. The glut of inventories had a marked depressing effect on LP gas and natural gasoline prices, resulting in a 2-percent decline in LP gas value in Texas to 3.16 cents per gallon in 1963. Natural gasoline values in Texas dropped 1 percent to 6.59 cents per gallon. Total domestic demand for LP gases increased nearly 6 percent to 11,370 million gallons, according to the industry's principal marketer. Commercial and domestic markets accounted for 44 percent of total LP gas demand, and chemical manufacturing markets accounted for 40 percent. Other markets included engine fuel, gas manufacturing, and industrial.

The industry completed or was building 21 new gas processing plants including 19 gasoline plants and 2 sweetening plants in 1963. Processing capacity of six operating plants was expanded—there were six plants shut down including the famous Opelika plant of Lone Star Producing Co. Shell Oil Co. built four new gas processing plants—a 42-million-cubic-foot cycling plant with daily recovery of 352,000 gallons of stabilized condensate at Bryans Mill in Cass County, a 20-million-cubic-foot-per-day refrigeration unit recovering 52,000-gallons-per-day of liquids near McCamey in Crockett County, a 1.5-million-cubic-foot-per-day refrigeration unit in Hardeman County recovering 17,000-gallons-per-day of liquids, and a 20-million-cubic-foot-per-day refrigeration absorption plant with 32,000-gallons-per-day recovery of liquids in the Person field in Karnes County. Other completions included Humble Oil Co. 42.8-million-cubic-foot-per-day refrigeration-absorption plant at Kellers Bay, Calhoun County, recovering 33,700 gallons per day of liquids and Hunt Oil Co. 30-million-cubic-foot-per-day refrigeration-absorption plant in the Fairway field in Henderson County. Daily liquid recovery of Hunt plant was 97,000 gallons.

Petroleum.—The State's oil industry continued to be faced with excessive stocks of crude oil and refined products in spite of the 4-percent

increase in domestic demand. The net result was softened crude and product prices, continued gasoline-price war in the midcontinent region, and a marked cut back in drilling projects. Crude oil prices declined 20 cents per barrel on some west-central Texas production, about 17 cents per barrel for certain west Texas sour crudes, nearly 15 cents for some east Texas crudes, and about 18 cents for some southwest Texas production. Total 1963 income loss to Texas producers approached $4 million.

Interest in east Texas salt domes rose with development of oil production from the Paluxy zone on the northeast flank of Grand Saline Dome in Van Zandt County and the Pettit gas condensate zone on the west flank of Bethel Dome in Anderson County.

Bandera County entered the State's producer list with a modest oil discovery from Pennsylvanian limestone. Gulf Oil Co. discovery well, No. 1 Gallant, gauged 10 barrels of 36 gravity crude daily at 4,417 to 4,578 feet with nearest production 40 to 50 miles away.

TABLE 13.—Crude petroleum production, indicated demand, and stocks, in 1963, by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks originating in Texas	Month	Production	Indicated demand	Stocks originating in Texas
January	78,754	83,230	102,568	September	80,528	79,374	103,495
February	75,269	79,971	97,866	October	83,594	85,494	101,595
March	81,875	81,875	97,866	November	79,792	81,241	100,146
April	80,018	76,893	100,991	December	83,078	83,775	99,449
May	82,588	81,628	101,951				
June	80,065	78,881	103,135	Total:			
July	83,583	81,598	105,120	1963 [1]	973,097	980,692	----------
August	83,953	86,732	102,841	1962	943,328	936,087	----------

[1] Preliminary figures.

TABLE 14.—Petroleum daily average production and runs to stills

(Thousand barrels)

Month	1962		1963	
	Crude production	Runs to stills	Crude production	Runs to stills
January	2,651	2,287	2,540	2,410
February	2,681	2,324	2,688	2,493
March	2,574	2,188	2,641	2,357
April	2,596	2,262	2,667	2,352
May	2,536	2,314	2,664	2,426
June	2,562	2,352	2,669	2,406
July	2,537	2,293	2,696	2,370
August	2,518	2,381	2,708	2,432
September	2,554	2,237	2,684	2,260
October	2,516	2,276	2,697	2,421
November	2,560	2,298	2,660	2,477
December	2,517	2,335	2,680	2,419

The oil industry increased secondary recovery projects in sprawling Slaughter-Levelland fields in Cochran and Hockley Counties during 1963. Seven waterfloods encompassing 21,953 acres and 595 wells operated or had Railroad Commission approval. Primary production from the leases was estimated at 100 million barrels with an additional recovery of 140 million barrels by flooding. Fourteen more flood

projects, mostly in the Slaughter area, were in varying planning stages. Ten of the projects involved 41,344 acres and 1,202 wells. The 4 Levelland projects included 20,600 acres and 370 wells. Together, they represent a contemplated added recovery of 600 to 650 million barrels of crude over primary production.

Two other new waterflood projects of west Texas included Pan American Petroleum Co., Goldsmith-Landreth unit, involving 6,066 acres and 226 wells in Ector County and Amerada Petroleum Adair San Andres unit involving 5,258 acres and 108 wells in Gaines and Terry Counties.

Texas Railroad Commission banned flaring gas in the Fort Trinidad field of Madison and Houston Counties in east Texas late in September. The Commission ordered any well still flaring to be shut in until the gas could be conserved.

Oil operators began filing Railroad Commission oil production reports (Form EB) in July 1963 with the Commission's Austin office instead of district offices. The change resulted from the electric data processing program to speed compilation of reports and reduce paperwork at field offices to permit utilization of more time and personnel in engineering work.

In one of the oil industry's largest financial deals, Sinclair Oil Corp. agreed to purchase nearly all assets of Texas Gulf Producing Co. for about $250 million. Sinclair will acquire the domestic and foreign producing properties of Texas Gulf Producing. Texas Gulf produces crude in Libya and Peru.

The year-long strike at the Houston refinery of Shell Oil Co.—one of the longest in the oil industry—was settled in mid-August. The action involved about 2,000 employees. Refinery operations were continued during the strike by company technical and supervisory personnel.

The State's 198,236 oil wells produced 2,666,020 barrels daily or 13.4 barrels per well daily in 1963, compared with the 2,584,500-barrel daily production or 13.1 barrels per well daily in 1962. Crude oil was reported from 199 counties of the State's 254 counties with the 5 leading counties in order of production as follows: Andrews, Ector, Crane, Scurry, and Gaines. Average daily indicated demand for crude oil was 2,686,800 barrels, up 5 percent from that of 1962.

Beginning crude oil stocks at Texas refineries as of December 31, 1962, were 94,297,000 barrels; stocks declined to a total of 85,839,000 barrels as of December 31, 1963. Texas refineries received 74,706,000 barrels of domestic crude oil in 1963 of which 56,710.000 barrels were produced in the State, 47,000 barrels were received from Alabama and Mississippi, 14,378,000 barrels from Louisiana, 2,927,000 barrels from New Mexico, 359,000 barrels from Oklahoma and 284,000 barrels from Utah. Pipelines carried 86 percent of the crude oil, railroads and trucks 1 percent, and tankers and barges 13 percent. At yearend, 43 refineries were operating in Texas at a rated capacity of 2,730,210 barrels daily, 89 percent of which was at plants along the Gulf Coast. Eight refineries were idle during the year, representing 51,100 barrels of daily capacity. Texas refinery capacity represented 26.6 percent of total domestic capacity. Daily average runs to stills amounted to 2,738,000 barrels, with Texas production representing 75.9 percent of receipts. There were refineries in 31 counties of the State.

TABLE 15.—Runs to stills and output of refineries in 1963, by months

(Thousand barrels)

Month	Runs			Output					
	Crude	Products	Rerun	Gasoline	Kerosine	Fuel oil		Jet fuel	Miscellaneous
						Distillate	Residual		
January	74,698	7,715	295	38,189	5,669	22,072	3,440	2,800	10,538
February	69,816	6,543	−1,568	34,243	5,257	19,914	3,556	2,179	9,642
March	73,053	7,507	407	37,529	4,849	20,982	3,834	2,525	11,248
April	70,560	7,839	−3,020	35,714	4,648	17,554	3,689	2,187	11,587
May	75,192	8,194	−4,223	38,681	3,811	18,252	3,902	2,325	12,192
June	72,177	7,755	−1,539	38,334	4,050	17,427	3,450	2,440	12,692
July	73,468	7,721	−661	38,878	4,389	18,136	3,647	2,973	12,505
August	75,403	8,562	−1,712	40,130	4,827	18,519	3,115	2,998	12,664
September	67,808	8,593	708	37,265	3,941	18,520	2,844	2,534	12,005
October	75,064	8,708	−3,500	39,748	5,078	18,615	2,673	1,933	12,225
November	74,299	8,252	−3,217	37,952	5,681	19,107	3,388	1,850	11,356
December	74,991	8,041	−2,387	39,488	5,671	19,036	2,848	1,891	11,711
Total:									
1963	876,529	95,430	−20,417	456,151	57,871	228,134	40,386	28,635	140,365
1962	837,820	88,506	−21,015	461,077	52,958	212,646	42,460	32,030	104,338

TABLE 16.—Stocks of crude petroleum at refineries, tank farms, and gathering systems in 1963, by months

(Thousand barrels)

Month	Refineries	Tank farms and pipelines	Lease tanks	Total
January	15,042	67,347	7,754	90,143
February	16,581	62,603	7,724	86,908
March	16,231	61,761	7,839	85,831
April	16,834	64,266	7,726	88,826
May	15,979	63,656	7,582	87,217
June	17,201	66,067	7,720	90,988
July	16,507	69,436	7,731	93,674
August	15,908	67,995	7,550	91,453
September	15,887	69,464	7,774	93,125
October	14,942	66,938	7,686	89,566
November	13,705	65,982	7,767	87,454
December	13,414	64,672	7,753	85,839

TABLE 17.—Stocks of refined products by refineries with plants and pipelines in 1963, by months

(Thousand barrels)

Month	Gasoline [1]	Kerosine	Fuel oil		Jet fuel	Natural gas liquids	Miscellaneous products
			Distillate	Residual			
January	38,185	3,728	13,599	6,468	2,713	1,120	29,623
February	39,362	3,512	11,092	6,336	2,513	1,207	29,923
March	39,909	2,774	9,084	5,370	2,942	1,520	28,483
April	35,030	3,523	11,980	5,255	2,721	1,933	30,536
May	31,339	3,321	14,532	5,819	2,992	1,937	32,879
June	31,031	3,996	18,623	5,800	2,785	2,072	32,844
July	29,192	4,044	20,898	5,998	2,885	2,498	31,412
August	28,432	4,603	22,265	6,113	2,534	2,406	31,108
September	28,857	4,909	24,895	6,160	2,089	1,857	28,665
October	31,922	5,851	26,286	5,720	2,119	1,571	29,815
November	29,352	5,400	23,513	5,904	1,714	1,679	30,857
December	30,154	4,901	18,870	5,920	1,670	1,534	30,276

[1] Includes naphtha.

New additions and expansions to the State's refining facilities included: A 700-barrel-per-day catalytic polymerization unit was nearing completion at the Corpus Christi refinery of Coastal States Petrochemical Co. Shell Oil Co. was building a 38,000-barrel-per-day catalytic-feed hydrogen treating unit and a 13,000-barrel-per-day depropanizer at its Pasadena refinery. A 1,500-barrel-per-day cat reformer, a 750-barrel-per-day hydrogen treating unit, and a 500-barrel-per-day lube unit were being built at the Pasadena refinery of Texas Asphalt & Refining Co. Union Texas Petroleum, Division of Allied Chemical Corp., was increasing the crude charge of its Winnie refinery to 10,650 barrels per stream day. Platforming capacity was likewise raised to 6,100 barrels per day from 3,600. A 300-barrel-per-day Udex unit was being installed as well as a 3,000-barrel-per-day Isomax hydrocracking unit. Atlantic Refining Co. increased crude charge capacity of its Port Arthur refinery from 65,000 to 87,000 barrels per stream day. California Oil Co. added 300 barrels per stream day to the sulfuric acid alkylation capacity of its El Paso refinery. Humble Oil & Refining Co. increased acid alkylation capacity of its Baytown refinery to 22,500 barrels per stream day. Fresh feed capacity of the Texas City refinery cat cracking unit was raised to 20,000 barrels per day and its recycle to 20,000 barrels.

Petrochemicals.—A major portion of the Nation's petrochemical industry was located along the Gulf Coast of Texas and Louisiana. This industry was steadily increasing its proportion of total chemical products and consuming greater quantities of petroleum fractions and natural gas in producing a wide variety of first and second generation petrochemicals to be used in making synthetic fibers and rubbers, detergents, solvents, rayon, pharmaceuticals, plastics, and a host of other products. Nearly 60 percent of domestic ethylene capacity is in the State. A recent industry survey by the Houston Chamber of Commerce showed 187 Gulf Coast chemical plants which produced 415 varied chemical products. An estimated $4 to $5 billion has been invested in chemical plants of the Gulf Coast. Major centers of the Texas petrochemical industry included: Beaumont-Port Arthur-Orange area; Houston-Texas City-Freeport area; Corpus Christi, and Brownsville on the Gulf Coast. Inland centers were Odessa-Big Spring area, Borger-Etter-Pampa area, and Longview.

The State's petrochemical industry added new facilities and expanded existing ones during 1963. Significant projects were as follows: a 35-million-pound-per-year polypropylene resin and film plant was built on the Houston Ship Channel by Alamo Polymer Corp., jointly owned by Phillips Petroleum and National Distillers; a $3.5 million, 60-ton-per-day anhydrous ammonia plant was being built near Dimmitt, Castro County, by Western Ammonia Corp.; Odessa Natural Gasoline Co. completed a 25,000-ton-per-year anhydrous ammonia plant at Brownfield; Premier Petrochemical Co. planned a $4 million, 70,000-ton-per-year prilled urea plant on the Houston Ship Channel; American Oil Co. completed a 600-ton-per-day anhydrous ammonia unit at its Texas City refinery complex. A 166-ton-per-day anhydrous ammonia unit was completed by W. R. Grace Co. at Big Spring. Lone Star Producing Co. began construction of a $25-million fertilizer plant on the Trinity River near Kerens. Daily plant ca-

pacities include a 320-ton ammonia unit, a 260-ton urea unit, a 144-ton nitric acid unit, a 360-ton ammonium nitrate unit, and a 275-ton ammonium phosphate unit; the plant will process 10 to 20 million cubic feet of gas per day. Best Fertilizer Co. built a 200,000-ton-per-year complex at Plainview to produce anhydrous ammonia, ammonium phosphate, and related products. Tenneco began a $9-million ammonia plant in Houston. The company added a 100-million-pound-per-year acetylene unit and a 200-million-pound-per-year vinyl chloride unit to its Houston complex. Channel black plants were being built by Coastal States Gas Producing Co. in Comanche County and by Draper-Goodale in Newton County. E. I. du Pont de Nemours & Co., Inc., completed a 30-million-pound-per-year "Nordel" rubber unit at its Beaumont complex and was building a 225-ton-per-day anhydrous ammonia plant at Victoria. A 30-million-pound-per-year polypropylene unit was added to the Odessa complex of El Paso Natural Gas and Rexall Drug. Capacities for producing acetyl chemicals at the Bay City, Bishop, and Pampa chemical complexes of Celanese Chemical Co. were increased 100 million pounds by additional facilities and another 100 million pounds by process improvement in existing facilities. Combined annual capacity of the three plants will be 700 million pounds when all projects are completed in early 1964. Jefferson Chemical Co., jointly owned by Texaco, Inc., and American Cyanamid Co. will build a 150-million-pound-per-year ethylene oxide unit at its Port Neches chemical complex. Cyclohexane capacity of the Smiths Bluff refinery of Pure Oil Co. was raised 20 million gallons per year. The material is used in production of nylon and other synthetic products. A 40-million-pound-per-year methyl ethyl ketone unit was planned for the Channelview complex of Sinclair Petrochemicals, Inc., a subsidiary of Sinclair Oil Corp. The ketone is widely used as a solvent in coatings, plastics, and petroleum refining industries. Union Carbide Co. announced it would increase acetic acid capacity of its Brownsville chemical plant by 200 million pounds annually. Expansion of its liquid oxygen and nitrogen facilities at Deer Park (Houston) was also planned. Goodyear Chemical Division of Goodyear Tire & Rubber Co. completed a $20-million, 20,000-ton-per-year cis 1, 4 polyisoprene unit at its Beaumont synthetic rubber plant. This capacity is equivalent to annual output of a 45,000-acre rubber plantation containing 4.5 million rubber trees. A rubber tree requires nearly 7 years growth to produce rubber latex; synthetic rubber can be polymerized in a matter of hours.

Pipelines.—Competition for the Nation's bulk transport business among railroads, barge and ocean freight, trucks, and pipelines increased in 1963 with the start of two giant pipeline projects—the Colonial products line from Texas to New York City and a pulverized coal pipeline from West Virginia to Philadelphia and New York. Pipelines have accounted for 17 percent of intercity freight traffic for several years. With advent of larger diameter lines and transportation of intermediate and finished bulk products, pipelines were acquiring a much larger share of this billion dollar market. The established systems—railroads, trucks, and water carriers—were striving to circumvent the changes and reduce their losses.

Several economic factors favoring pipeline development were (1) growing market areas for bulk commodities, (2) ability of pipelines to use lateral lines to service markets adjacent to trunk lines, (3) larger diameter pipe allowing greater capacity per investment dollar, and (4) larger capacity permitting more favorable amortization of costs and lower unit transportation costs. The new Houston to New York pipeline can move a barrel of product for about 35 cents, approximating tanker tariffs. In addition, the pipeline can service markets along its route, far removed from seaports.

Competition was increasing in the $1.8 billion supplier pipeline market between established steel, aluminum, and metal pipe and plastic pipe. Plastic pipe manufacturers had internal competition with polyethylene (PE) pipe sharing markets with fast growing polyvinyl chloride (PVC), acrylonitrile-butadiene-styrene (ABS), and polypropylene (PP) pipe.

Supplementary benefits from Colonial products pipeline originating near Houston included the 50-percent increase in bulk storage capacity at a tank terminal to 4.5 million barrels. The tank terminal is the property of General American Transportation Corp. The first consignment of refinery products to the $350 million Colonial pipeline entered the line at the Houston terminus on September 16, 1963, for transfer to Greensboro, N.C., 1,050 miles away. The first shipment—a 100,000 barrel batch of unleaded gasoline—was supplied by Sinclair and Phillips refineries in the area. The pipeline will receive products from refineries of Mobil, Gulf, Pure, and Texaco at its Beaumont-Port Arthur intake and from Cities Service and Continental refineries at its Lake Charles, La., intake.

Major pipeline construction in 1963 included the following: a $43 million, 290-mile pipeline of 36- and 30-inch pipe from the King Ranch cycle plant of Humble Oil & Refining Co. to Baytown which will more than double the company's present line capacity of 300 million cubic feet per day; Houston Lighting & Power Co. will be the largest customer when the line is completed in 1965. Lone Star Gas Co. was building a $3-million, 100-mile pipeline to gather 40 million cubic feet of gas daily from fields in Victoria, De Witt, Karnes, and Goliad Counties. Magnolia Pipeline Co. will build an 82-mile system of 8-inch, 6-inch, and 4-inch lines to gather and transport crude and condensate from Pecos, Reeves, and Ward Counties to Winkler County. Natural Gas Pipeline Co. of America planned a 43-mile, 16-inch and a 31.5-mile, 12-inch lateral supply line from the terminus of its existing 26-inch line in Jim Wells County to the Willamar field in Willacy County and 19.5 miles of 8-inch lateral from the Encinitas-Kelsey fields in Brooks County to a connection with the Willacy County line. A 65-mile, 6-inch pipeline from the San Jacinto Gas Processing Corp. plant near Port Acres to near Baytown was completed at a cost of $1 million for Union Carbide Corp. Suntide Pipe Line Co. built a $1 million, 60-mile pipeline from its Corpus Christi refinery to Seeligson and Falfurrias oilfields in Jim Wells County. Mid-Continent Pipe Line Co. built a 56-mile crude line connecting certain Delaware Basin oilfields with its Hailey station. Odessa Natural Gas Co. built a 92-mile, 16-inch gas pipeline from Crane

County gasfields to Colorado City. One of the Nation's largest water supply systems serving waterflood units in 10 west Texas oilfields was being built by Shell Pipe Line Corp. The 130-mile pipeline will furnish 600,000 gallons of brackish water per day from the Captain Reef complex near Kermit, Winkler County, to 45 waterflood units in Ector and Andrews Counties. The system will serve 86 percent of Ector County wells. Waterflooding was expected to increase field production by 70 percent and extend operations for 40 years.

NONMETALS

There were 17 nonmetals produced in Texas in 1963 valued at $307 million, 6 percent greater than the 1962 value. Value increases were reported by 11 nonmetal commodities, 2 reported no change, and 4 reported value losses. All construction materials reported increases.

Most construction material output and value advanced from 1962 levels and generally followed business indicators of the State. Cement shipments increased nearly 11 percent, exceeding the 1959 record by 6 percent. The advance was due in part to the new McDonough Co. (Gulf Coast Portland Cement Co.) cement plant at Houston and Southwestern Portland Cement Company's new plant at Amarillo, to doubling of capacity of the Midlothian plant of Texas Industries, Inc., and to a modest improvement in capacity operations of the rest of the State's cement industry. Cement prices stabilized after several years of severe competition for markets in addition to significant idle plant capacities. Output of clays used in manufacturing brick, tile, and cement rose 12 percent. Chemical and paper industries contributed to better markets for lime. The chemical industry was responsible for greater demand for salt, particularly salt in brine. The expanding State highway program and increased construction demands resulted in a 13 percent advance in tonnage of stone output; value advanced 10 percent. A cursory analysis indicated that crushed stone was beginning to absorb some aggregate markets of the sand and gravel industry, particularly in several growing metropolitan areas where local sand and gravel deposits were depleted. Sand and gravel production advanced nearly 11 percent during 1963. Other nonmetals reporting improved 1963 operations were barite, bromine, graphite, and magnesium compounds; those reporting lower 1963 outputs were pumicite, sulfur, talc and soapstone, and sodium sulfate.

A $1 million clay and sand processing plant was being built at Kosse in Limestone County by Magnet Cove Barium Corp. Plant will process 150,000 tons of glass sand and 60,000 tons of kaolin per year. Facilities also included research and quality control laboratories.

Sulphur Export Corp., jointly owned by the four major Frasch sulfur producers, announced plans for two 26,400-ton tankers for liquid sulfur transportation to storage facilities at Rotterdam, Holland. Two 1,500-ton barges will transship the molten sulfur to customers in Belgium and the Netherlands. The U.S. sulfur producers will face keener competition in Western European markets in 1964 when Société Nationale des Petrols d'Aquitaine (SNPA) begins liquid sulfur deliveries. SNPA recovers sulfur from the Lacq gasfields of southeastern France.

Asphalt (Natural).—The accelerated highway construction program in 1963 by both State and county units permitted high-level output by two producers in Uvalde County. The natural material was being used more in new highway construction than in the past.

Barite.—Barite was produced from limestones of the Permian, Delaware Mountain formation and processed at a mill near Van Horn by Continental Minerals Co. Quantity and value of output was larger in 1963 than in 1962. Crude barite from other States and from foreign countries was processed at the Corpus Christi plant of National Lead Co., Baroid Division, the Brownsville plant of Magnet Cove Barium Corp., and the Houston plant of The Milwhite Co. Output of ground barite declined in 1963 following the trend of its major market—drilling mud.

Bromine.—Texas ranked second in the Nation in recovery of bromine. Ethyl-Dow Chemical Co. recovered bromine from sea water at its Freeport, Brazoria County, plant. Quantity and value in 1963 was greater than in 1962. Most of the bromine was consumed as ethylene dibromide, an additive in antiknock compounds. Smaller quantities of bromine were used for fumigation of soil and seeds and as pharmaceutical intermediates. The oil-refining industry of Texas consumed most of the antiknock fluid, but substantial amounts were shipped to out-of-State markets.

Cement.—Production, shipments, and value of cement in Texas established new records in 1963 as the industry expanded and improved its production, handling, and storage facilities during the year. Output was raised 10 percent and shipments increased 11 percent. Output originated from 16 plants in 11 counties—1 less plant than in 1962. Five leading cement producing counties listed, in order of output, were Harris, Dallas, Bexar, Tarrant, and Ellis. Limestone was the basic raw material for 10 of the inland cement plants; 6 plants along the gulf coast used shell. Trade circles expected another cement producer in the near future since a large, vertically-integrated construction company without cement producing facilities acquired an idle Government plant. Bushland cement plant of Southwestern Portland Cement Co. began trial runs late in 1963 with regular production planned for early 1964.

TABLE 18.—Portland cement production, shipment, and consumption

(Thousand 376 pound barrels and thousand dollars)

Year	Production	Shipments		Consumption		
					Percent change	
		Quantity	Value	Quantity	Texas	United States
1954–58 (average)	23,749	23,591	$67,590	20,430		
1959	27,111	27,215	85,022	23,884	+7	+9
1960	23,190	22,721	73,964	20,195	−15	−7
1961	24,889	25,101	80,808	21,566	+7	+3
1962	26,443	26,204	83,162	22,900	+6	+3
1963	29,150	29,104	92,734	24,618	+8	+5

Clays.—Clay production established a new record in 1963 exceeding the previous 1959 record 8.5 percent in quantity and 20 percent in value. Bentonitic clay production increased 2 percent over that of 1962, with production in Angelina, Fayette, Gonzales, and Walker Counites. Heavy drilling muds consumed nearly 80 percent of the output; the remaining 20 percent was used as filtering and decolorizing agents. The 1963 output of fire clay was 31 percent greater than that of 1962 with production reported in 13 counties; Bastrop, Rusk, and Henderson Counties were principal producers. Heavy clay products consisting of building and face brick, drain tile, sewer pipe, and kindred commodities consumed nearly 70 percent of the output with refractories comprising the remainder. Fuller's earth production in Fayette County increased nearly 4 percent and was principally used as decolorizing agent for vegetable and mineral oils, additive for drilling muds, carrier for insecticides, and filtering and clarifying agent. Miscellaneous clay output increased 9 percent in quantity and 7 percent in value as compared with 1962. Output occurred in 38 counties with Galveston, Dallas, Harris, Eastland, and Bexar Counties leading in production. Over 90 percent of the clay was used in manufacture of brick, heavy clay products, and cement; lightweight aggregate and tile manufacture required the remainder. Clay demand by lightweight aggregate producers improved as their markets expanded.

TABLE 19.—Clays sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Bentonite		Fire clay		Miscellaneous clay		Total [1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1954-58 (average)	134	$1,159	445	$1,291	2,480	$2,877	3,059	$5,327
1959	133	947	722	1,596	3,015	3,160	3,870	5,703
1960	116	873	715	1,668	2,471	2,517	3,302	5,058
1961	122	900	676	1,660	2,988	3,177	3,786	5,737
1962	118	873	615	1,558	3,011	3,203	3,744	5,634
1963	120	1,366	808	2,054	3,271	3,429	4,199	6,849

[1] Incomplete total, excludes fuller's earth.

The 25-million-brick-per-year plant of Acme Brick Co. at Denton began production late in 1963. The company expanded grinding and blending facilities at its Fraser plant in Seguin. Texas Clay Tile Co. began production in March 1963 at its 70,000-brick-per-day plant at Malakoff. Various types of clay from deposits in the vicinity of Malakoff were used at the plant.

Graphite.—Natural flake graphite was quarried and refined in Burnet County. Production in 1963 was greater than in 1962. The product is used largely in crucibles and foundry facings in the steel industry.

Gypsum.—Crude gypsum was produced by seven operators in five counties. Output was 2 percent under that of 1962 and 19 percent less than the record 1959 output. Gypsum deposits are widely distributed over the State with principal sources in Fisher, Hardeman,

and Nolan Counties. Gypsum was also recovered from open pits in the Malone Mountains of Hudspeth County. Most of the gypsum was used in manufacturing building and industrial plasters, wallboard, and lath.

TABLE 20.—Crude gypsum mined

Year	Short tons	Value	Year	Short tons	Value
1954–58 (average)	1,201,545	$3,815,883	1961	1,073,671	$3,832,000
1959	1,351,060	4,770,228	1962	1,119,955	3,955,889
1960	1,131,034	3,960,361	1963	1,099,371	3,998,569

Lime.—Lime production established a record, exceeding the 1962 record by 8 percent. Quicklime accounted for 51 percent of the output and hydrated lime the remainder. Production was reported from 12 plants in 10 counties. Limestone was used in manufacture of 55 percent of the lime and shell in the remaining 45 percent. Principal markets for both captive and open market lime were chemical (alkali manufacture), steel, paper and pulp, masonry, and water treatment. Important quantities of lime were used as a soil stabilization agent for roads, airport runways, and parking lots. A total of 284,299 tons of lime was used by highway contractors to stabilize 17.8 million square yards of subgrade. In this way, the clay subgrade was waterproofed thus permitting quick drying and protection against cracking of the asphalt seal over the clay.

Austin White Lime Co. expanded both quarry and lime operations in 1963. A new crushing and screening plant to produce kiln stone, fluxing stone, flexible road base, and agricultural lime was installed. The company added a new rotary lime kiln to increase lime calcining capacity by 220 tons per day and new lime hydrating and milling equipment to increase hydrated lime capacity by 360 tons per day.

TABLE 21.—Lime sold or used by producers

Year	Quicklime (short tons)	Hydrated lime (short tons)	Total	
			Short tons	Value (thousands)
1954–58 (average)	387,435	254,861	642,296	$6,509
1959	414,052	394,725	808,777	8,530
1960	433,405	388,037	821,442	9,087
1961	412,063	377,475	789,538	8,703
1962	585,214	461,042	1,046,256	11,999
1963	571,515	559,690	1,131,205	13,026

Magnesium Compounds.—Production of both magnesium compounds and magnesium chloride used for metal was greater than that of 1962. The commodities were recovered from seawater at the Dow Chemical Co. plant at Freeport, Brazoria County. Other potential sources included subsurface brines and also surface waters containing magnesium in association with other mineral salts of some of the larger playa lakes of the High Plains. Principal market for State output of magnesium compounds was refractory magnesia.

Natural Salines.—Natural sodium sulfate was recovered from shallow salt brines in Terry and Ward Counties by Ozark-Mahoning Co.; no changes were reported in its capacities or processes. Most of the output was used in preparing salt cake for the kraft paper, glass, ceramic glazes, detergent, and other miscellaneous markets. New producers increased competition and resulted in softer prices.

Perlite (Expanded).—Though no crude perlite was produced in Texas in 1963; six plants in four counties expanded crude material from other States and from foreign countries. Output and value were down 5 percent in 1963. Principal markets included aggregates for building plaster and concrete, loose fill insulation, oil well cement, and filler and wallboard.

Pumicite (Volcanic Ash).—Pumicite was mined from open pits in Tertiary strata in Starr County for use as a concrete admixture and as an insecticide diluent.

Salt.—Salt was recovered from underground mines and from wells. Output was 7 percent greater and value 15 percent greater than in 1962 when the previous record high was established. Evaporated salt accounted for 2 percent of the total tonnage, rock salt for 5 percent, and brine for the remaining 93 percent. Output was reported by 11 producers from 10 counties. Most of the production was consumed by the State's chemical industry in manufacturing chlorine, hydrochloric acid and other chlorine compounds, and sodium compounds.

TABLE 22.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954-58 (average)	3,773	$13,753	1961	4,695	$17,682
1959	4,519	17,498	1962	5,553	19,485
1960	4,756	18,222	1963	5,965	22,355

Sand and Gravel.—Sand and gravel output increased 11 percent in quantity and 10 percent in value. Production was reported from 112 counties by 212 commercial and 122 Government-and-contractor operations. Commercial production accounted for 83 percent of the quantity and 88 percent of the value. Washed material accounted for 94 percent of the commercial output with an average value of $1.21 per ton; only 76 percent of the Government-and-contractor sand and gravel was washed or processed. Average value of all sand and gravel produced was $1.09 per ton, compared with $1.10 per ton in 1962. Sand consumption by use was building, 72 percent; paving, 18 percent; fill, 5 percent; other construction and glass sand, each 1 percent; and molding, blast, engine, filtration, hydrafrac, other industrial, and railroad-ballast sand, less than 1 percent each. Gravel consumption by use was building, 50 percent; paving, 48 percent; fill, 1 percent; and miscellaneous, railroad ballast, and other construction sand, less than 1 percent each. The sand and gravel was moved by truck (76 percent), rail (23 percent), and water (1 percent).

TABLE 23.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total sand and gravel	
	Quantity	Value	Quantity	Value	Quantity	Value
1954–58 (average)	23,518	$25,278	5,227	$1,676	28,745	$26,954
1959	29,520	32,098	5,775	2,628	35,295	34,726
1960	26,918	29,857	2,926	897	29,844	30,754
1961	23,272	27,975	4,126	2,716	27,398	30,691
1962	25,619	29,948	4,457	3,149	30,076	33,097
1963	27,511	32,085	5,745	4,226	33,256	36,311

TABLE 24.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	7,396	$6,735	9,585	$9,245
Paving	3,771	3,914	2,045	2,002
Fill	390	165	594	249
Other [1]	541	1,852	722	1,935
Total	12,098	12,666	12,946	13,431
Gravel:				
Building	6,517	8,764	9,814	13,192
Paving	6,487	8,220	4,340	5,174
Fill	196	70	198	94
Other [2]	321	228	213	194
Total	13,521	17,282	14,565	18,654
Total sand and gravel	25,619	29,948	27,511	32,085
Government-and-contractor operations:				
Sand:				
Building	6	8	76	191
Paving	271	118	352	160
Fill	10	4	82	33
Total	287	130	510	384
Gravel:				
Building	18	26	8	17
Paving	4,152	2,993	5,227	3,825
Total	4,170	3,019	5,235	3,842
Total sand and gravel	4,457	3,149	5,745	4,226
Grand total	30,076	33,097	33,256	36,311

[1] Includes railroad, other construction sand, and industrial sand (unground and ground).
[2] Includes railroad ballast, miscellaneous, and other construction gravel.

Stone.—Total quantity of stone produced, including shell, was 13 percent greater and value was 10 percent greater than in 1962. Commercial stone accounted for 82 percent of quantity and 87 percent of total value and averaged $1.33 per ton. Limestone accounted for 73 percent. The remaining stone output comprised basalt, granite, percent of the gross output, shell for 23 percent, and sandstone for 3 marble, and miscellaneous stone.

Granite.—Crushed and dimension granite were produced in three counties; output was considerably less than that of 1962. Crushed granite was used primarily for riprap. Dimension granite was used for dressed and rough architectural stone, rough monumental stone, construction stone, and as rubble building stone.

TABLE 25.—Stone sold or used by producers, by kinds

(Thousand short ton and thousand dollars)

Year	Limestone		Sandstone		Shell		Miscellaneous		Total [1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1959	29,141	$30,064	2,406	$1,189	10,310	$14,419	177	$257	42,172	$47,787
1960	26,620	26,208	1,816	1,036	10,304	15,798	159	212	39,029	45,088
1961	24,439	25,718	2,266	1,511	10,531	15,373	905	695	38,316	45,874
1962	25,717	27,851	1,266	2,045	10,073	14,701	584	499	38,067	48,988
1963	31,375	34,682	1,412	1,756	9,804	14,026	271	252	43,142	54,007

[1] Includes other stone to avoid disclosing individual company confidential data.

Limestone.—Crushed limestone (including that used in manufacture of cement and lime) was produced in 69 counties at 176 operations, 95 of which were commercial. Value increased 24 percent and production 22 percent. Total commercial production accounted for 78 percent of the gross with an average value of $1.12 per ton. Seventy percent of crushed limestone was used as roadstone and aggregate in concrete; other important uses included riprap, metallurgical flux, railroad ballast, aglime, and filler (for asphalt, paint, etc.). Over 69 percent of commercial crushed limestone (excluding that used in manufacture of lime and cement) was hauled by truck and 27 percent by rail. The five principal limestone-producing counties in order of output were Wise, Bexar, Comal, McLennan, and Williamson. The quantity of dimension limestone reported by six producers from four counties was 72 percent greater and the value was 44 percent greater than in 1962. Rough architectural stone accounted for 49 percent of the use, dressed building stone for 50 percent, and rubble, rough construction stone, and flagging stone for the remainder. The dimension stone value averaged $1.75 per cubic foot.

Marble.—Marble was quarried and prepared as terrazzo chips, roofing material, and paint filler by one producer in Llano County.

Sandstone.—Output of crushed sandstone reported by 17 producers from 16 counties was 12 percent greater than that of 1962. Approximately 64 percent of the crushed sandstone was produced for Texas highway department districts to use for aggregate in concrete and road surfacing. Dimension sandstone for use in rough construction was quarried by one producer in Parker County.

Shell.—Shell output from bays of six Gulf Coast counties decreased 3 percent in quantity and decreased 5 percent in value, compared with 1962. The major part of the output was used for concrete aggregate and in manufacturing cement and lime; shell was also used as asphalt filler and poultry grit.

Miscellaneous Stone.—Miscellaneous stone, including rhyolite, graphitic schist, and other stone, was quarried and crushed for use as

roadstone, aggregate in concrete, riprap, filtering material, roofing granules, and railroad ballast by two commercial producers and three Government-and-contractor producers in five counties. Both quantity and value were considerably less than in 1962.

Sulfur.—Although free world demand for sulfur in 1963 rose nearly 6 percent and domestic demand advanced nearly 10 percent to a new record, domestic Frasch output declined 8 percent from that of 1962 and shipments faltered 4 percent as competition for world and domestic markets from new sources in Mexico, Canada, and France increased. Industry data did show, however, that the persistent imbalance of the past 5 years between sulfur supplies and demand had abated with resultant firming of sulfur prices from the $20 per ton low in 1962. Improvement in industrial activity and the fast growing markets for fertilizers have buoyed the future outlook of the industry.

Output of sulfur recovered from sour gases and crude oils rose 15 percent over 1962 production and 12 percent over shipments.

Domestic sulfur producers increased the number and capacity of regional liquid sulfur storage and transshipment terminals along inland waterways and eastern seaboard. These producers, through the Sulfur Export Corp., were building two 26,400-ton tankers for 1964 delivery to carry liquid sulfur to foreign ports. Three 12,000-ton heated storage tanks, storage areas for solid sulfur, and a solid smelter and filter were being built at Rotterdam by the corporation. Two 1,500-ton insulated barges would transship the molten sulfur to markets in the Netherlands and Belgium.

TABLE 26.—Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments		Year	Production	Shipments	
		Quantity	Value			Quantity	Value
1954–58 (average)	3,422	3,235	$84,158	1661	2,778	2,730	$62,720
1959	2,519	2,970	68,998	1962	2,622	2,655	57,297
1960	2,679	2,747	62,855	1963	2,413	2,550	50,109

A 40-long-ton-per-day sulfur recovery unit was being built at the Houston refinery acquired by Signal Oil & Gas Co. during 1963.

Talc and Soapstone.—Output of crude talc was slightly less than that of 1962. Seven operations in two counties, Gillespie and Hudspeth, were responsible for the output. Soapstone was produced at one mine in Gillespie County. Development of the Allamoore talc deposits continued during the year. The 120-ton-per-day grinding mill operated by Pioneer Talc Co. at Allamoore processed crude talc from its own pit and from pits of other producers.

Vermiculite (Exfoliated).—Crude vermiculite from other States and foreign countries was processed at four plants in three counties for use as lightweight aggregate for plaster and concrete and as loose-fill insulation.

METALS

The State's metal mining industry was limited to iron and uranium with magnesium metal being recovered by chemical methods from Gulf sea water. An important primary metals industry processed ores and concentrates from other States and from foreign countries at plants listed in table 27. Primary metals production was supplemented by metals recovered from scrap.

Plants processing scrap metal included:

Dallas:	
ABASCO, Inc	aluminum
National Lead Co., Southwestern Branch	lead
American Smelting & Refining Co	lead-zinc
Dixie Lead Co	lead
Southern Lead Co	lead, tin, antimony
El Paso: Border Steel Mills, Inc	iron-steel
Fort Worth:	
National Metal & Smelting Co	aluminum, lead
Texas Steel Co	iron-steel
Houston:	
A & B Metal Manufacturing Co., Inc	tungsten carbide
Federated Metals Division of American Smelting & Refining Co	alloys of copper, lead, zinc, magnesium, tin
Gulf Reduction Corp	alloys of aluminum, zinc
Houston Lead Co. and Lead Products Co., Inc	lead
Sterling Type, Rule, & Metals Co	type metal
Vulcan Detinning Co., Division of Vulcan Materials	tin
Laredo: Wilkinson Bros. Smelting Co	lead
Longview: R. G. LeTourneau, Inc	iron and steel
Seguin: Structural Metals, Inc	iron and steel

TABLE 27.—Smelters, refineries, and reduction plants in 1963

Product, company, and plant	County	Material treated	Source of Material
Aluminum:			
Aluminum Co. of America:			
Port Comfort (alumina)	Calhoun	Bauxite	Foreign.
Port Comfort (reduction)	do	Alumina	
Rockdale (reduction)	Milam	do	
Reynolds Metals Co.:			
Sherwin Works	San Patricio	Bauxite	Foreign.
San Patricio	do	Alumina	
Antimony: National Lead Co.: Laredo smelter	Webb	Ore	Foreign.
Cadmium: American Smelting & Refining Co.; electrolytic.	Nueces	Flue dust	Do.
Copper:			
American Smelting & Refining Co.: El Paso smelter.	El Paso	Ore and concentrates.	Foreign and domestic.
Phelps-Dodge Refining Corp.: Nichols refinery	do	Blister and anode.	Domestic.
Iron:			
Lone Star Steel Co.: Daingerfield plant	Morris	Ore and scrap	Foreign and domestic.
Sheffield Div. of Armco Steel Corp.: Houston plant.	Harris	do	Do.
Lead: American Smelting & Refining Co.: El Paso smelter.	El Paso	Ore and concentrates.	Foreign.
Magnesium: Dow Chemical Co.: Freeport plant	Brazoria	Sea water	
Manganese: Tenn-Tex Alloy & Chemical Co	Harris	Ore	Foreign.
Tin-Tungsten: Wah Chang Co.: Texas City smelter	Galveston	do	Do.
Zinc:			
American Smelting & Refining Co.:			
Amarillo retort smelter	Potter	Ore and concentrates.	Foreign and domestic.
Corpus Christi electrolytic	Nueces	do	Foreign.
El Paso fuming plant	El Paso	Dusts and residues.	
American Zinc Co. of Illinois: Machovec smelter.	Moore	Concentrates and fumes.	Foreign and domestic.

A new combination slab and plate mill of Sheffield Division of Armco Steel Corp. began production in June. The new mill, at Houston, reduced 35-ton ingots to 14-inch slabs, then to 4-inch steel plates. Southwest markets for these steel plates included heavy construction and petroleum industries, ship building, petrochemical storage and transportation, and the Government missile and space programs.

A 9-mile, 5-inch aluminum pipeline will carry 25-million cubic feet per day of natural gas from Mustang Island gasfield to the Reynolds Metal Co. aluminum plant near Corpus Christi.

Aluminum.—Bauxite ores from Surinam and Dominican Republic were processed at the alumina plant of Aluminum Company of America. Jamaican bauxite was processed by Reynolds Metals Co. The alumina was further reduced to metal at reduction works near Corpus Christi, Point Comfort, and Rockdale. Both Aluminum Company of America and Reynolds Metals Co. increased metal output by reactivating closed potlines.

Aluminum Company of America was doubling alumina producing capacity of its Point Comfort plant to process increased shipments of Dominican Republic bauxite ores.

Kaiser Aluminum & Chemical Corp. acquired the Capitol Products Corp. aluminum extrusion plant 3 miles south of Sherman in Grayson County. This is Kaiser's first Texas producing facility.

Antimony.—Antimony ores from Mexico were treated at the Laredo smelter of National Lead Co. Reduction in imports coupled with continued high demand resulted in sharp metal stock reduction and higher metal prices.

Cadmium.—Cadmium was recovered as a byproduct from flue dust of other zinc smelters at the Corpus Christi smelter of American Smelting & Refining Co.

Copper.—Ore and concentrate supplies remained tight for the El Paso smelter of American Smelting & Refining Co., resulting in below capacity operations. Blister and anode copper from Arizona operations were fire and electrolytically refined at the Nichols refinery of Phelps-Dodge Refining Corp.

Iron Ore and Steel.—Open pit production of iron ore was reported from four operations in two counties; 1963 output was nearly 43 percent greater than that of 1962, and shipments were 27 percent greater. Most of the iron ore was used in making pig iron at the Houston steel works of Sheffield Division of Armco Steel Corp. and at the Daingerfield steel works of Lone Star Steel Co. Most production came from Cherokee and Morris Counties.

Pig iron and steel were produced at the Houston integrated mill of Sheffield Division of Armco Steel Corp. and at the Daingerfield works of Lone Star Steel Co. Operations in 1963 exceeded those of 1962 although demand for oil industry equipment and industrial steel products, both major markets, were below national trends.

Lead.—Ores and concentrates from other States and from foreign countries were treated at the El Paso lead works of American Smelting & Refining Co. Operations remained below capacity because of tight concentrate market.

Magnesium and Magnesium Compounds.—Dow Chemical Co. recovered magnesium metal and magnesia from sea water by an electrochemical

process. Output in 1963 exceeded that of 1962 with the two plants, Freeport and Velasco, operating at about 70 percent of capacity. Aluminum alloying was the major market, but die casting requirements showed the largest growth. Use of magnesium as a reductant in metals production, particularly for titanium and ductile iron, also was growing.

Manganese.—Ferroalloys, including ferromanganese, were processed from foreign manganese ores at the Houston plant of Tenn-Tex Alloy & Chemical Corp.

Tin-Tungsten.—Tin and tungsten were recovered from foreign ores and concentrates at the Texas City smelter of Wah Chang Corp. during 1963.

A new electrolytic tin smelting unit began production in mid-July at the Texas City smelter of Wah Chang Corp. The new facilities will enable the company to treat complex Bolivian tin concentrates and secondary materials to produce high-purity tin metal. Long term purchase contracts for tin concentrates with Corporacion Minera de Bolivia and Banco Minero de Bolivia supplement Indonesian ore contracts, which were terminated in December 1962.

Wah Chang was negotiating long-term supply contracts with major U.S. steel companies and other tin consumers.

Uranium.—The 200-ton-a-day uranium mill of Susquehanna-Western Inc., near Falls City, processed ores from Karnes and Live Oak Counties.

Zinc.—Zinc retort facilities at Amarillo and Dumas and the electrolytic zinc plant at Corpus Christi operated at higher levels in 1963 as metal demand and price advances continued throughout the year.

REVIEW BY COUNTIES

This review is limited to those counties having significant mineral production or industry information. (See table 28 for additional details.)

Anderson.—Value of mineral fuels increased 3 percent over that of 1962. Twenty exploratory drilling projects discovered 1 gasfield, and 21 oil and 6 gas wells were proved with 39 development projects. Crude oil was processed at the 2,400-barrel-per-day refinery of Anderson Refining Corp. Three gas processing plants recovered natural gas liquids.

Andrews.—Andrews County was first in oil production and in total value of minerals produced in 1963. Seven oilfields were discovered from 18 exploratory wells as 175 development wells proved 159 oil and 4 gas wells. Seven gasoline plants recovered natural gas liquids. Pan American Petroleum Corp. expanded its Midland Farms plant capacity. Sulfur was recovered from natural gas at plants of J. L. Parker Co. and Pan American Petroleum Corp.

Angelina.—Total mineral value in Angelina County increased 14 percent as compared with 1962. Exploration drilling was limited to two tests, both proving oil discoveries. Bentonitic clays were mined from open pits by Bennett-Clark Co., Inc., and Magnet Cove Barium Corp. Other nonmetallic mineral production included lime by Southland Paper Mills, Inc., sand and gravel by the U.S. Forest Service, and some miscellaneous stone.

TABLE 28.—Value of mineral production in Texas, by counties[1]

County	1962[2]	1963	Minerals produced in 1963 in order of value
Anderson	$22,714,164	$23,487,827	Petroleum, natural gas, natural gas liquids.
Andrews	231,928,789	234,969,174	Petroleum, natural gas liquids, natural gas.
Angelina	555,235	630,593	Clays, natural gas, petroleum, stone, sand and gravel.
Aransas	9,885,561	9,756,429	Petroleum, natural gas, natural gas liquids, shell.
Archer	28,779,016	29,588,113	Petroleum, natural gas liquids, natural gas, stone.
Atascosa	15,606,210	15,325,895	Petroleum, natural gas, natural gas liquids, sand and gravel.
Austin	6,370,557	6,453,909	Do.
Bandera	----------	2,800	Petroleum.
Bastrop	849,158	916,976	Clays, petroleum, natural gas.
Baylor	7,327,125	7,701,003	Petroleum, sand and gravel, natural gas.
Bee	16,152,371	15,630,026	Natural gas, petroleum, natural gas liquids, stone.
Bell	(3)	(3)	Sand and gravel, stone.
Bexar	18,843,337	19,459,667	Cement, stone, sand and gravel, petroleum, clays.
Blanco	15,036	3,437	Sand and gravel.
Borden	25,998,900	26,680,646	Petroleum, natural gas, sand and gravel.
Bosque	1,045	7,834	Sand and gravel.
Bowie	(3)	438,993	Sand and gravel, natural gas, petroleum.
Brazoria	161,752,519	166,245,260	Petroleum, natural gas, magnesium chloride, natural gas liquids, bromine, salt, lime, magnesium compounds, sulfur, sand and gravel.
Brazos	113,185	117,387	Natural gas.
Brewster	(3)	(3)	Clays.
Briscoe	46,000	(3)	Stone, clays.
Brooks	20,000,927	20,485,146	Natural gas, petroleum, natural gas liquids.
Brown	2,132,619	2,356,382	Stone, petroleum, natural gas, clays.
Burleson	18,760	104,549	Stone, sand and gravel, petroleum.
Burnet	3,876,627	3,892,919	Stone, graphite, sand and gravel.
Caldwell	9,492,415	9,745,936	Petroleum, natural gas.
Calhoun	21,995,820	22,228,381	Natural gas, petroleum, natural gas liquids, lime, shell, sand and gravel.
Callahan	7,192,677	7,563,170	Petroleum, natural gas, stone.
Cameron	468,818	485,998	Natural gas, petroleum.
Camp	1,451,614	1,490,388	Petroleum, natural gas.
Carson	29,841,781	30,411,986	Natural gas, petroleum, natural gas liquids.
Cass	12,831,555	11,087,525	Petroleum, natural gas liquids, natural gas.
Chambers	59,741,526	60,635,766	Petroleum, natural gas, shell, salt, natural gas liquids, sand and gravel.
Cherokee	6,925,383	7,104,651	Petroleum, iron ore, natural gas, natural gas liquids, clays.
Childress	764,624	779,628	Petroleum, stone, natural gas, sand and gravel.
Clay	12,368,879	12,665,036	Petroleum, natural gas, stone.
Cochran	25,916,960	26,531,840	Petroleum, natural gas, natural gas liquids.
Coke	29,403,101	31,312,534	Petroleum, natural gas liquids, natural gas, sand and gravel.
Coleman	10,504,865	11,115,618	Petroleum, natural gas, natural gas liquids, sand and gravel, stone, clays.
Collin	240,500	57,000	Stone.
Collingsworth	868,143	877,554	Natural gas.
Colorado	22,401,248	22,292,789	Natural gas, natural gas liquids, sand and gravel, petroleum.
Comal	4,406,586	3,948,214	Stone, lime, sand and gravel.
Comanche	272,605	399,870	Stone, petroleum, natural gas, sand and gravel.
Concho	927,448	952,701	Petroleum, natural gas.
Cooke	29,920,965	30,703,307	Petroleum, natural gas liquids, sand and gravel, natural gas, stone.
Coryell	----------	30,335	Stone.
Cottle	7,560	267,762	Sand and gravel, petroleum.
Crane	133,517,999	135,575,770	Petroleum, natural gas liquids, natural gas.
Crockett	23,447,699	24,070,002	Petroleum, natural gas, natural gas liquids, gem stones.
Crosby	(3)	1,242,735	Sand and gravel, petroleum.
Culberson	3,777,377	3,800,247	Petroleum, natural gas, barite.
Dallam	138,784	143,936	Natural gas.
Dallas	17,817,086	21,089,030	Cement, sand and gravel, stone, clays.
Dawson	20,215,047	20,631,100	Petroleum, natural gas liquids, natural gas, stone.
Denton	570,118	612,359	Petroleum, natural gas, sand and gravel, clays, stone.
DeWitt	8,439,118	8,734,850	Petroleum, natural gas, stone, natural gas liquids, sand and gravel.
Dickens	169,859	125,195	Petroleum, natural gas.
Dimmit	1,002,108	1,029,294	Do.
Donley	66,576	57,191	Sand and gravel, natural gas.
Duval	35,394,752	37,607,862	Petroleum.
Eastland	4,725,651	4,907,711	Petroleum, natural gas liquids, natural gas, clays, stone.
Ector	211,224,733	213,051,124	Petroleum, natural gas liquids, natural gas, cement, stone, clays.
Edwards	1,714	1,760	Petroleum.

See footnotes at end of table.

TABLE 28.—Value of mineral production in Texas, by counties [1]—Continued

County	1962 [2]	1963	Minerals produced in 1963 in order of value
Ellis	(3)	$8,117,078	Cement, stone, clays, sand and gravel.
El Paso	$5,286,138	4,935,648	Cement, stone, sand and gravel.
Erath	2,242,427	1,978,064	Natural gas, natural gas liquids, petroleum, stone, sand and gravel.
Falls	121,723	90,200	Stone, petroleum, natural gas.
Fayette	1,569,785	1,784,480	Sand and gravel, petroleum, clays, stone, natural gas.
Fisher	15,062,550	15,657,714	Petroleum, gypsum, natural gas liquids, natural gas, clays.
Floyd	(3)	(3)	Sand and gravel, petroleum.
Foard	3,010,928	3,181,601	Petroleum, sand and gravel, natural gas.
Fort Bend	34,422,553	34,333,988	Petroleum, sulfur, natural gas, salt, natural gas liquids, clays, sand and gravel.
Franklin	13,761,560	12,618,541	Petroleum, natural gas liquids, natural gas.
Freestone	4,206,037	4,036,816	Petroleum, natural gas, stone, clays.
Frio	4,835,782	4,966,465	Petroleum, natural gas, natural gas liquids.
Gaines	91,602,308	93,861,904	Petroleum, natural gas, natural gas liquids, stone.
Galveston	42,789,374	43,804,197	Petroleum, natural gas, shell, clays, natural gas liquids, sand and gravel.
Garza	17,201,053	17,660,943	Petroleum, natural gas.
Gillespie	76,796	100,952	Sand and gravel, stone, soapstone.
Glasscock	5,260,645	5,405,066	Petroleum, natural gas.
Goliad	9,179,234	9,422,797	Natural gas, petroleum, natural gas liquids.
Gonzales	447,653	612,917	Clays, petroleum, sand and gravel, stone, natural gas.
Gray	57,875,794	57,650,562	Petroleum, natural gas, natural gas liquids.
Grayson	27,619,074	27,452,580	Petroleum, natural gas liquids, stone, natural gas, sand and gravel.
Gregg	95,448,463	97,286,646	Petroleum, natural gas liquids, natural gas.
Grimes	40,900	436,168	Stone, natural gas.
Guadalupe	12,190,809	12,398,143	Petroleum, clays, natural gas.
Hale	1,386,958	1,424,246	Petroleum, natural gas.
Hamilton	85,645	108,238	Natural gas, stone.
Hansford	24,338,059	24,447,578	Natural gas, petroleum, natural gas liquids.
Hardeman	3,752,643	4,058,887	Petroleum, gypsum, natural gas liquids.
Hardin	27,539,766	28,105,308	Petroleum, natural gas, natural gas liquids, sand and gravel.
Harris	101,558,224	119,805,795	Petroleum, cement, natural gas liquids, natural gas, salt, sand and gravel, lime, clays.
Harrison	23,281,836	20,940,994	Natural gas, petroleum, natural gas liquids, lignite, clays, stone.
Hartley	2,075,424	2,151,399	Natural gas, petroleum.
Haskell	13,719,566	14,092,217	Petroleum, natural gas.
Hays	7,127	19,572	Sand and gravel, stone.
Hemphill	541,903	558,618	Petroleum, natural gas.
Henderson	13,390,740	14,480,149	Petroleum, natural gas, natural gas liquids, sand and gravel, clays.
Hidalgo	31,190,789	31,637,865	Natural gas, natural gas liquids, petroleum, sand and gravel, stone, clays.
Hill	74,359	3,726	Petroleum.
Hockley	31,382,746	32,238,894	Petroleum, natural gas liquids, natural gas.
Hopkins	5,534,942	5,550,635	Petroleum, natural gas, natural gas liquids, clays.
Houston	3,831,694	4,555,414	Petroleum, natural gas, natural gas liquids, sand and gravel.
Howard	42,716,088	44,236,155	Petroleum, natural gas liquids, sand and gravel, natural gas, stone.
Hudspeth	988,725	1,414,420	Sand and gravel, talc, stone, gypsum.
Hunt	132,415	137,140	Natural gas, petroleum.
Hutchinson	61,971,119	61,071,281	Petroleum, natural gas liquids, natural gas, stone, sand and gravel, salt.
Irion	2,237,027	2,431,589	Petroleum, natural gas liquids, natural gas.
Jack	18,374,799	18,787,710	Petroleum, natural gas, natural gas liquids.
Jackson	44,004,677	44,664,619	Petroleum, natural gas, natural gas liquids, sand and gravel.
Jasper	2,398,845	2,500,628	Petroleum, natural gas, clays, lime, sand and gravel, natural gas liquids.
Jefferson	69,092,432	65,842,516	Petroleum, sulfur, natural gas, natural gas liquids, salt, sand and gravel, clays.
Jim Hogg	17,499,483	18,027,889	Petroleum, natural gas, natural gas liquids.
Jim Wells	56,861,404	57,276,313	Do.
Johnson	1,569,721	1,425,843	Lime, stone, sand and gravel.
Jones	18,296,551	18,648,294	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Karnes	13,397,083	13,245,835	Petroleum, natural gas, natural gas liquids, uranium.
Kaufman	1,852,058	2,139,837	Petroleum, stone, natural gas.
Kendall	9,016	3,550	Sand and gravel.
Kenedy	4,456,710	4,400,844	Natural gas, petroleum, natural gas liquids.
Kent	26,314,321	27,020,936	Petroleum, natural gas, sand and gravel.
Kerr	(3)	(3)	Sand and gravel.

See footnotes at end of table.

TABLE 28.—Value of mineral production in Texas, by counties [1]—Continued

County	1962 [2]	1963	Minerals produced in 1963 in order of value
Kimble	$19,153	$44,641	Sand and gravel, natural gas, petroleum.
King	3,269,830	3,193,632	Petroleum, natural gas.
Kleberg	67,741,158	71,163,005	Petroleum, natural gas, natural gas liquids, stone.
Knox	6,882,440	7,146,434	Petroleum, sand and gravel, natural gas.
Lamb	5,259,008	5,452,374	Petroleum, stone, natural gas.
Lampasas	33,276	126,618	Stone, sand and gravel.
La Salle	1,381,163	1,423,753	Petroleum, natural gas.
Lavaca	16,889,964	13,165,319	Natural gas liquids, natural gas, petroleum, sand and gravel, stone.
Lee	64,768	66,517	Petroleum, natural gas.
Leon	4,220,337	4,787,171	Petroleum, natural gas, natural gas liquids, stone.
Liberty	34,603,039	33,921,619	Petroleum, sulfur, natural gas, sand and gravel, natural gas liquids.
Limestone	2,196,183	2,216,778	Natural gas, petroleum, stone, clays.
Lipscomb	4,016,000	4,131,326	Petroleum, natural gas.
Live Oak	20,159,073	21,111,852	Natural gas, natural gas liquids, petroleum, uranium.
Llano	1,633,441	1,583,114	Stone.
Loving	11,480,462	11,790,393	Petroleum, natural gas.
Lubbock	1,329,981	1,383,424	Petroleum, sand and gravel, natural gas.
Lynn	1,708,969	1,759,013	Petroleum, natural gas, sand and gravel.
Madison	1,812,119	1,844,339	Petroleum, natural gas, natural gas liquids.
Marion	5,435,042	5,539,690	Petroleum, natural gas, natural gas liquids.
Martin	7,169,987	7,361,644	Petroleum, natural gas.
Mason	10,533	11,219	Sand and gravel.
Matagorda	48,482,221	50,002,173	Natural gas, petroleum, natural gas liquids, shell, sand and gravel, clays.
Maverick	2,498,081	2,619,091	Petroleum, natural gas liquids, natural gas.
McCulloch	(3)	596,965	Sand and gravel, natural gas, petroleum.
McLennan	5,164,530	6,984,387	Cement, sand and gravel, stone, clays, petroleum, natural gas.
McMullen	9,712,413	9,998,880	Natural gas, petroleum, natural gas liquids.
Medina	1,327,535	1,362,025	Petroleum, clays, natural gas.
Menard	398,601	385,369	Petroleum, sand and gravel, natural gas.
Midland	65,326,503	64,467,964	Petroleum, natural gas, natural gas liquids, stone.
Milam	(3)	(3)	Lignite, petroleum, sand and gravel, stone.
Mills	----------	20,510	Stone.
Mitchell	7,101,395	7,269,424	Petroleum, natural gas, sand and gravel.
Montague	19,929,326	20,017,393	Petroleum, natural gas, natural gas liquids, stone, sand and gravel.
Montgomery	26,556,825	26,872,343	Petroleum, natural gas, natural gas liquids, sand and gravel.
Moore	56,719,901	54,504,631	Natural gas, natural gas liquids, helium, petroleum.
Morris	(3)	(3)	Iron ore.
Motley	1,200,759	1,414,525	Petroleum, sand and gravel.
Nacogdoches	3,054,111	3,166,335	Natural gas, clays, natural gas liquids, petroleum.
Navarro	6,829,778	7,213,485	Petroleum, sand and gravel, stone, natural gas, clays.
Newton	7,903,262	7,742,976	Petroleum, natural gas, natural gas liquids.
Nolan	26,929,443	26,344,570	Petroleum, cement, natural gas liquids, gypsum, natural gas, stone. sand and gravel.
Nueces	75,525,597	75,642,287	Natural gas, petroleum, natural gas liquids, cement, lime, shell, sand and gravel.
Ochiltree	21,124,676	21,689,831	Petroleum, natural gas, natural gas liquids.
Oldham	(3)	506,135	Sand and gravel, clays, petroleum, natural gas.
Orange	13,188,947	13,148,524	Petroleum, natural gas, cement, natural gas liquids, clays, sand and gravel.
Palo Pinto	2,716,336	2,993,660	Natural gas, natural gas liquids, petroleum, clays, sand and gravel.
Panola	49,400,941	46,930,500	Natural gas, petroleum, natural gas liquids.
Parker	2,621,343	2,575,383	Natural gas liquids, natural gas, stone, clays, petroleum, sand and gravel.
Pecos	60,218,335	62,318,754	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Polk	4,641,135	4,885,780	Petroleum, natural gas, stone, sand and gravel, natural gas liquids.
Potter	13,659,618	15,091,891	Natural gas, helium, natural gas liquids, sand and gravel.
Presidio	----------	24,476	Stone, gem stones.
Rains	1,864	1,933	Natural gas.
Randall	----------	62,582	Sand and gravel.
Reagan	25,415,478	23,936,978	Petroleum, natural gas liquids, natural gas.
Real	51,946	----------	
Red River	93,870	96,407	Petroleum, natural gas.
Reeves	8,482,491	8,833,620	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Refugio	70,161,824	72,084,332	Petroleum, natural gas, natural gas liquids.
Roberts	5,434,841	5,598,871	Petroleum, natural gas.
Robertson	484,504	513,460	Sand and gravel, petroleum, clays, natural gas.
Runnels	15,425,636	15,507,785	Petroleum, natural gas, natural gas liquids.

See footnotes at end of table.

TABLE 28.—Value of mineral production in Texas, by counties [1]—Continued

County	1962 [2]	1963	Minerals produced in 1963 in order of value
Rusk	$61,541,486	$63,248,610	Petroleum, natural gas, natural gas liquids, clays.
Sabine	1,232	574	Sand and gravel, natural gas.
San Augustine	2,316	2,379	Petroleum, natural gas.
San Jacinto	1,807,712	1,850,571	Petroleum, natural gas, sand and gravel.
San Patricio	45,034,079	45,666,517	Petroleum, natural gas, natural gas liquids, sand and gravel, stone, clays.
Schleicher	12,016,552	12,279,573	Petroleum, natural gas, natural gas liquids.
Scurry	104,381,493	106,980,970	Petroleum, natural gas liquids, natural gas, stone, sand and gravel, clays.
Shackelford	10,974,999	11,195,844	Petroleum, natural gas, natural gas liquids.
Shelby	1,212,968	1,375,130	Natural gas, stone, petroleum, sand and gravel.
Sherman	17,782,418	18,442,222	Natural gas, petroleum.
Smith	9,947,207	10,171,582	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Somervell	40,000	87,728	Stone.
Starr	29,259,748	29,715,271	Petroleum, natural gas, natural gas liquids, pumicite, clays.
Stephens	9,181,691	9,153,278	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Sterling	3,119,738	3,209,836	Petroleum, natural gas.
Stonewall	18,652,316	19,059,085	Petroleum, natural gas liquids, natural gas, sand and gravel.
Sutton	607,624	630,024	Natural gas, petroleum.
Tarrant	10,446,140	11,584,482	Cement, sand and gravel, stone.
Taylor	14,072,685	15,012,193	Petroleum, natural gas, sand and gravel, stone, natural gas liquids, clays.
Terrell	3,278,841	3,428,353	Natural gas, stone.
Terry	18,687,198	18,805,694	Petroleum, sodium sulfate, natural gas liquids, natural gas.
Throckmorton	8,695,161	8,951,450	Petroleum, natural gas, sand and gravel, stone.
Titus	14,300,569	14,682,524	Petroleum, natural gas.
Tom Green	7,325,671	6,682,570	Petroleum, natural gas, natural gas liquids, sand and gravel.
Travis	3,749,234	4,784,456	Lime, sand and gravel, stone, petroleum.
Trinity		54,375	Stone.
Tyler	2,408,574	2,477,930	Petroleum, natural gas.
Upshur	5,531,630	5,665,250	Petroleum, natural gas, sand and gravel.
Upton	48,509,254	47,387,839	Petroleum, natural gas liquids, natural gas.
Uvalde	[3]	[3]	Asphalt, sand and gravel, basalt.
Val Verde	614,092	772,148	Natural gas, stone, petroleum.
Van Zandt	19,039,720	20,491,605	Petroleum, salt, natural gas liquids, natural gas, clays.
Victoria	24,851,972	25,594,320	Petroleum, natural gas, sand and gravel, natural gas liquids.
Walker	183,144	973,020	Stone, clays, petroleum.
Waller	38,397,824	34,572,075	Natural gas, natural gas liquids, petroleum, sand and gravel.
Ward	71,617,133	72,786,000	Petroleum, natural gas, natural gas liquids, sodium sulfate, sand and gravel, salt, gypsum.
Washington	559,317	974,126	Petroleum, stone, natural gas.
Webb	8,769,637	8,902,154	Petroleum, natural gas liquids, natural gas, stone, sand and gravel, clays, gem stones.
Wharton	47,782,410	46,547,692	Sulfur, petroleum, natural gas, natural gas liquids, sand and gravel.
Wheeler	8,153,479	8,382,573	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Wichita	34,511,474	35,215,238	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Wilbarger	19,038,418	19,494,052	Petroleum, natural gas, sand and gravel.
Willacy	6,713,229	6,901,412	Petroleum, natural gas, natural gas liquids.
Williamson	3,439,809	4,434,921	Stone, lime, petroleum.
Wilson	1,721,157	1,743,949	Petroleum, clays, natural gas.
Winkler	114,438,309	117,533,406	Petroleum, natural gas, natural gas liquids.
Wise	29,368,870	31,091,962	Petroleum, natural gas, natural gas liquids, stone, sand and gravel, clays.
Wood	46,783,898	51,649,335	Petroleum, natural gas liquids, natural gas, clays, sand and gravel.
Yoakum	50,041,402	50,587,941	Petroleum, natural gas liquids, natural gas, salt.
Young	18,242,266	18,570,984	Petroleum, natural gas, natural gas liquids, sand and gravel.
Zapata	4,129,508	4,201,550	Natural gas, petroleum.
Zavala	1,501,572	1,545,245	Petroleum, natural gas.
Undistributed	24,452,516	20,010,348	
Total	4,323,557,000	4,413,084,000	

[1] The following counties are not listed because no production was reported in 1962 or 1963: Armstrong, Bailey, Castro, Deaf Smith, Delta, Fannin, Hall, Hood, Jeff Davis, Kinney, Lamar, Parmer, Rockwall, San Saba, and Swisher.

[2] Revised figures.

[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Aransas.—One gasfield was discovered from 7 exploratory projects, and 7 oil and 8 gas wells were proved by 19 development tests. Two gas processing plants recovered natural gas liquids. Carbon black was recovered from natural gas and natural gas liquids at plants of United Carbon Co., Inc. Heldenfels Bros. dredged shell from shallow bays for use as roadstone and concrete aggregate.

Archer.—Value of minerals produced in Archer County advanced 3 percent in 1963. Exploratory drilling discovered 11 oilfields—development drilling proved 225 oil wells. Warren Petroleum Corp. recovered natural gas liquids at its Holliday gasoline plant. Crushed sandstone was produced on contract for District 3 of the Texas Highway Department.

Atascosa.—The value of minerals was 2 percent less than that of 1962. Of 23 exploratory wells drilled, 2 were oilfield discoveries—development drilling proved 35 oil and 2 gas wells with 53 tests. Natural gas liquids were recovered at Jourdanton gasoline plant of Humble Oil & Refining Co. Sulfur was recovered from sour gas by Gillring Oil Co. and National Sulphur Co. Industrial sand was prepared by Espey Silica Sand Co.

Bandera.—Mineral production in 1963 was limited to the county's first oil production which began in October with completion of the Gulf Oil Co. discovery well on J. A. Gallant ranch near Medina.

Bastrop.—Mineral production rose 8 percent as compared with that of 1962. Fire clay was mined from open pits by Elgin-Butler Brick Co., Elgin-Standard Brick Manufacturing Co., and Payne Brick Co. for use in manufacturing brick and tile. Crude oil and natural gas were also produced during the year. Exploratory drilling resulted in 1 oil discovery from 12 tests; 2 oil wells were proved with 6 development tests.

Baylor.—Value of minerals produced in Baylor County increased 5 percent. One oilfield was discovered and 32 oil wells were proved by exploration and development drilling. Sand and gravel for concrete aggregate and for roadstone was produced on contract for District 3 of Texas Highway Department.

Bee.—The petroleum industry proved 3 oil and 6 gas discoveries with 32 exploration tests and added 19 oil wells and 22 gas wells with 49 development wells. Heldenfels Bros. quarried and crushed limestone (caliche) for concrete aggregate. Natural gas liquids were recovered from Burnell-N. Pettus field by Pan American Petroleum Corp. and from Normanna field by Tidewater Oil Co.

Bell.—Value of crushed limestone and sand and gravel produced in the county was 10 percent less than in 1962. Paving gravel and crushed limestone for concrete aggregate and roadstone were produced on contract for District 9 of Texas Highway Department. Building sand and gravel was produced by Belton Sand and Gravel Co., Inc.

Bexar.—Value of mineral output was 3 percent greater than in 1962. The county was second in stone output and third in cement and clay. Portland and masonry cements were produced by Longhorn Portland Cement Co. and San Antonio Portland Cement Co. Thirteen sand and gravel producers prepared 2.1 million tons, valued at $1.8 million. Fire clay and miscellaneous clay were mined from open pits by five

producers. Major clay uses included building and face brick, heavy clay products, and lightweight aggregate. Limestone for concrete aggregate, roadstone, riprap, aglime, railroad ballast, and other uses was quarried and crushed by six producers; two cement producers quarried and crushed limestone for manufacture of cement. Exploratory drilling failed to find any new oil or gas but development drilling added 40 oil wells. Crude oil was processed at refineries of Monarch Refining Co., Howell Refining Co., Inc., and Flint Chemical Co.

Borden.—Value of mineral fuels produced in Borden County was 3 percent greater than 1962. Development drilling proved 9 oil wells from 17 tests. Four oilfields in the county produced more than 1 million barrels each. Building and paving sand and gravel were produced by R. E. Janes Gravel Co., Inc.

Bowie.—Building and paving sand and gravel were produced by Gifford-Hill & Co., Inc., and Bruce Kennedy Sand & Gravel Co. Crude oil and natural gas were also produced in the county. The ammonium nitrate unit of the Lone Star Ordnance plant at Texarkana was opened for leasing.

Brazoria.—The county ranked first in value of lime, magnesium metal, salt, and natural gas; third in total mineral value. It also had the largest ethylene producing capacity—1,760 million pounds per year. Two oilfields and 5 gasfields were discovered; 32 oil wells and 13 gas wells resulted from 73 development projects. Four oilfields in the county produced more than 1 million barrels each. Gas processing plants of Humble Oil & Refining Co., Pan American Petroleum Corp., Monsanto Chemical Co., and Phillips Petroleum Co., and one cycle plant recovered natural gas liquids. Monsanto Chemical Co. will produce biodegradable detergent intermediates at the Chocolate Bayou plant. Capacity of the plant will be 150 million pounds per year of straight-chain alkyl-benzenes; commercial production was scheduled for 1964, with complete conversion to new products by 1965. At either Texas City or Chocolate Bayou, Monsanto will build a second acrylonitrile plant on the Gulf Coast; capacity will be about 115 million pounds per year. Completion will be in 1965. Crude oil was processed at Sweeny refinery of Phillips Petroleum Co. which also produced petrochemical feedstocks and intermediates. Dow Chemical Co. produced lime from shell and recovered magnesium compounds including magnesium chloride—used in production of magnesium metal—from sea water at its large Freeport chemical complex. The company recovered salt in brine for use in manufacture of organic and inorganic chemicals. Bromine was recovered from sea water by Ethyl-Dow Chemical Co. for manufacturing ethylene dibromide. Alkyl lead production was resumed in September at the 40-million-pound-per-year Freeport plant of Nalco Chemical Co.; the plant had been idled in early 1963 by fire and explosion. Sulfur was shipped from stockpile at Clemens Dome by Jefferson Lake Sulphur Co. Paving sand and gravel was produced by contractors for District 12 of Texas Highway Department.

Brewster.—Total mineral value was 10 percent less than in 1962. Carbonaceous earths used as soil conditioner were recovered from open pits 75 miles south of Alpine by Manning Minerals Corp. Fluor-

spar, imported from Mexico, was processed at the Alpine mill of Frampsar, Inc.

Briscoe.—Silverton Clay Products Corp. recovered fire clay from open pits for use as carrier for insecticides. Limestone was quarried and crushed for roadstone and aggregate for Texas Highway Department.

Brooks.—Two oil and 3 gasfields were discovered with 12 exploratory tests; 37 oil and 33 gas wells were proved with 83 development projects. United Carbon Co., Inc., recovered carbon black from natural gas at its Falfurrias channel plant. Humble Oil & Refining Co. recovered natural gas liquids at its new Viboras plant and its Mariposa gasoline plant.

Brown.—Value of mineral output was 10 percent over that of 1962. Limestone was quarried and crushed for concrete aggregate, riprap, railroad ballast, flux, roadstone, and other uses by Carson Quarrying and by G. C. McBride, Inc. Miscellaneous clays used in manufacturing brick and heavy clay products was mined from open pits by The Texas Brick Co. Crude oil and natural gas were produced in the county during the year.

Burleson.—Value of crude oil, stone, and sand and gravel production advanced appreciably in 1963. The Gulf, Colorado, and Santa Fe Railway Co. produced sand for railroad ballast. Limestone was quarried and crushed for concrete aggregate and roadstone by one producer.

Burnet.—The 1963 value of minerals approximated that of 1962. Southwestern Graphite Co. mined graphite from open pits and processed the material at its Burnet mill. Crushed granite for riprap and railroad ballast was quarried and crushed by one company; dimension granite for dressed architectural and rough construction stone and rubble was quarried and prepared by two companies. Limestone was quarried and processed for riprap, flux, concrete aggregate, railroad ballast, aglime, and other uses. Sand and gravel for paving use was reported.

Calhoun.—Ethylene capacity of 700 million pounds per year was third largest in the State. The petroleum industry discovered 1 oilfield and 2 gasfields through 11 exploratory drilling projects and added 4 oil wells and 7 gas wells with 15 development wells. Natural gas liquids were recovered at the new 42.8-million-cubic-foot-per-day plant in Kellers Bay field of Humble Oil & Refining Co. and five other gas processing plants. Aluminum Company of America made lime from shell for use in its Point Comfort alumina plant. Shell was dredged from shallow bays of Calhoun County by Bauer Dredging Co., Inc., and Smith Brothers Dredging Co., Inc. The Point Comfort aluminum plant of Aluminum Company of America processed Surinam and Dominican Republic bauxite ores to recover alumina; the alumina was processed to aluminum pigs and ingots at the reduction works. Sand was produced for paving purposes for Texas Highway Department.

A 330-million-pound-per-day styrene monomer unit will be added to Union Carbide Chemical Co. Seadrift complex. Ethyl benzene will be produced by high yield alkylation method and converted to styrene by direct dehydrogenation process.

Callahan.—Value of crude oil, natural gas, and stone produced increased 5 percent over that of 1962. Exploratory drilling resulted in discovery of 4 oilfields and 1 gasfield; 90 oil wells proved from development drilling added to production and reserves. Baird oil refinery of Premier Oil Refining Co. was being dismantled. Limestone was quarried and crushed by a contractor for Texas Highway Department.

Cameron.—Value of crude oil and natural gas output was 4 percent greater than in 1962. One gasfield was discovered from 10 exploration projects; 3 development tests proved 3 gas wells. Barite imported from Mexico and Canada was processed for heavy drilling muds by Magnet Cove Barium Corp. Acetic acid capacity of Union Carbide Corp. Chemical Division was to be increased 200 million pounds per year by 1965; new units would replace older and less efficient units at various locations. The Port Isabel oil refinery of Hess Oil & Chemical Corp. was shut down and dismantled.

Carson.—The county was again an important producer of crude oil, natural gas, and natural gas liquids with output 2 percent greater than that of 1962. Carbon black was recovered at the Skellytown channel plant of Cabot Carbon Co. Gasoline plants of the Dorchester Corp., Shell Oil Co., and Skelly Oil Co. recovered natural gas liquids. Oil and gas production and reserves were improved through 56 oil and 7 gas wells proved by development drilling.

Cass.—Mineral value declined 14 percent. Natural gas liquids were recovered by Breckenridge Gasoline Corp. Shell Oil Co. completed a 42-million-cubic-foot-per-day cycle plant in Bryans Mill field late in 1963 with stabilized liquid recovery of 352,000 gallons per day. Sulfur was recovered by Shell Oil Co.

Castro.—Western Ammonia Corp., Dimmitt, was building a $3.5-million anhydrous ammonia plant with capacity of 60 tons per day. Completion date was scheduled for February 1964.

Chambers.—The county led in shell production and was second in salt production. Three new oilfields were discovered; 80 oil wells and 13 gas wells resulted from development projects. The county had three oilfields producing in excess of 1 million barrels of crude oil each. Humble Oil & Refining Co. recovered natural gas liquids at its Anahuac gasoline plant. At Winnie, Allied Chemical Corp. was rehabilitating the former McCarthy Chemical Corp. plant to produce aromatic petrochemicals. Union Texas Petroleum, a division of Allied Chemical Corp., was constructing facilities for aromatics, specialty products, and solvents; input will be natural gas liquids and condensate. Salt in brine was obtained from Barbers Hill salt dome by Diamond Alkali Co. for use in manufacturing industrial chemicals. W. D. Haden Co. and Parker Brothers & Co., Inc., recovered shell for concrete aggregate, poultry grit, filler, and manufacture of paper and magnesium metal. Paving sand and gravel was produced by one operator.

Cherokee.—The East Texas oilfield extending over parts of three other counties with cumulative production of 3.6 billion barrels of crude oil, was largest producing oilfield in the State and Nation in 1963. Neches gasoline plant of Humble Oil & Refining Co. recovered natural gas liquids. Iron ore was mined from open pits by L. B. Haberle Mining Corp., Jennings & Halbert, and Sheffield Division

of Armco Steel Corp. Fire clay was recovered from open pits by General Refractories Co. and A. P. Green Fire Brick Co. for manufacture of fire brick and refractory shapes.

Clay.—Value of mineral production increased 2 percent in 1963. Four oilfields were discovered and 64 oil wells completed through exploratory and development drilling. Otha H. Grimes shut down its Ringgold gasoline plant. Sandstone was quarried and prepared for Texas Highway Department.

Cochran.—Total mineral value increased 2 percent over that of 1962. Slaughter and Levelland oilfields each produced in excess of 1 million barrels of crude. Development drilling added 34 oil wells to the county's oil production and reserves. Lehman gasoline plant of Cities Service Oil Co. recovered natural gas liquids from Levelland gasfield; sulfur was recovered at an adjacent facility by National Sulphur Co.

Coke.—Value of minerals increased 6 percent over that of 1962. Exploratory well drilling resulted in discovery of three oilfields. Natural gas liquids were recovered at plants of Union Texas Petroleum Division of Allied Chemical Corp., and Sun Oil Co. Building and paving sand and gravel were produced by Montgomery Sand & Gravel Co.

Coleman.—Four oilfields and two gasfields were discovered. Coleman County Regular oilfield produced in excess of 1 million barrels of crude. Howsley & Jacobs shut down its gasoline plant in Glen Cove field, leaving three small gasoline plants to recover liquids. Martin Brick Co. mined miscellaneous clay from open pits for manufacture of heavy clay products. Industrial sand was prepared by Santa Anna Silica Sand Co., Inc. Crushed limestone was quarried and prepared for concrete aggregate and roadstone for Texas Highway Department.

Colorado.—Total mineral value was somewhat less than in 1962. The county ranked first in sand and gravel output. Two oil wells and 22 gas wells were completed from 38 development tests. Natural gas liquids were recovered at the Sheridan cycling plant of Shell Oil Co. and the Chesterville gasoline plant of Tenneco Oil Co. Building and paving sand and gravel were produced by Texas Construction Material Co., Inc., Parker Brothers & Co., Inc., Thorstenberg Materials Co., Inc., and Horton & Horton. Contractors furnished sand and gravel for District 13 of Texas Highway Department.

Comal.—The 1963 value of minerals produced was 10 percent less than in 1962. Lime and stone output were third largest in the State. Lime was produced from limestone quarried and prepared by U.S. Gypsum Co. Crushed limestone was prepared for riprap, flux, railroad ballast, concrete aggregate, and other uses by Servtex Materials Co. Building and paving sand and gravel were prepared by Erhardt Kraft.

Cooke.—Minerals produced were valued at 3 percent more than in 1962. Exploratory drilling resulted in discovery of four oilfields and one gasfield. Cooke County Regular oilfield produced more than 1 million barrels of crude. Walnut Bend gasoline plant of Union Texas Petroleum, Division of Allied Chemical Corp., and Sivells Bend gasoline plant of Standard Oil Co. of Texas recovered natural gas liquids. The Tydal Co. processed crude oil at its Gainesville refinery. A triple

zone oil discovery—1 S. F. Murrell, 6 miles southwest of Dexter—was completed by Texas Pacific Coal & Oil Co. Paving sand and gravel and crushed limestone were produced on contract for District 3 of Texas Highway Department. Nelson Bros., Inc., produced building and paving sand and gravel.

Crane.—The county was fourth in total mineral value and third in oil production. Eight oilfields and two gasfields were discovered. The petroleum industry added to oil and gas production with 152 oil and 10 gas wells from development tests. Five gasoline plants recovered natural gas liquids from four gasfields. The Block 31 gas processing plant of Atlantic Refining Co. was modified to add refrigeration to the existing absorption unit which will raise liquid recovery from 113,000 gallons per day to 145,000 gallons. Sulfur was recovered from sour natural gas at the Crane plant of Phillips Petroleum Co. and Waddell plant of Warren Petroleum Corp.

Crockett.—Mineral value increased 3 percent over that of 1962. Exploratory drilling proved two oilfields—Escondido/L. Strawn and N.W. Ozona/Canyon—and one new gasfield—S.W. Ozona/Strawn. Shell Oil Co. completed a 20-million-cubic-foot-per-day gasoline plant to recover 52,000 gallons per day of liquids near McCamey. Cities Service Oil Co. recovered liquids at its West World plant. Todd Ranch plant of Continental Oil Co. was shut down.

Culberson.—Value of mineral production increased slightly over that of 1962. Two oilfields were discovered and development drilling added 21 oil wells to production and reserves. Barite was mined in the Seven Heart Gap area and processed at the Van Horn mill of Continental Minerals.

Dallas.—Value of minerals produced increased 18 percent. The county ranked second in cement, clay, and sand and gravel production. Portland and masonry cements were prepared by Lone Star Cement Corp. and by Trinity Portland Cement Division of General Portland Cement Co.; both companies quarried and crushed limestone for manufacturing the cement. Sand and gravel was prepared by 25 producers, and contractors produced paving gravel for District 18 of Texas Highway Department. Crude perlite and crude vermiculite produced in other States were processed at the Irving plant of Texas Lightweight Products Co. and at the Dallas plant of Texas Vermiculite Co. for concrete aggregate, roof decks, insulation, building plaster, and other uses. Miscellaneous clay was mined from open pits by Ferris Brick Co. for manufacture of building brick and heavy clay products and by Dallas Lightweight Aggregate Co. for manufacture of lightweight aggregate. The crude oil refinery of Great Western Producers, Inc., at Irving was dismantled. A 50 percent expansion of the high purity hydrogen gas plant of National Cylinder Gas, Division of Chemetron Corp., was planned.

Dawson.—Total mineral value in 1963 was 2 percent greater than in 1962. Exploratory drill projects discovered 1 new oilfield, S. Triple D/Wolfcamp, and 1 oil pool, Jo Mill/Fusselman; 39 oil wells were proved by development tests. Natural gas liquids were recovered at the Lamesa gas processing plant of Texaco, Inc. Calcareous quartzite for concrete aggregate and roadstone was quarried and crushed by Lone Star Materials, Inc.

Denton.—Mineral production increased 7 percent in value. Miscellaneous clay, used in making brick and heavy clay products, was mined from open pits by Acme Brick Co. Limestone was crushed and paving gravel was prepared by contractors for District 18 of Texas Highway Department.

De Witt.—Mineral value advanced 4 percent over 1962 value. Exploratory drilling proved 1 gas well from 10 tests and development drilling added 13 oil wells and 10 gas wells from 32 drill tests. A 20-million-cubic-foot-per-day gas sweetening plant was being built by Lone Star Gathering Co. Natural gas liquids were recovered at the Meyersville cycle plant of Industrial Gas Supply Corp. Contractors quarried and crushed sandstone for concrete aggregate and roadstone and sand and gravel for paving purposes for District 13 of Texas Highway Department.

Duval.—Mineral value increased 6 percent over that of 1962. The county was the third largest salt producer. Ten oilfields and 6 gasfields were discovered and 156 development projects proved 57 oil and 19 gas wells to add to the county's crude oil production and reserves. Hoffman oilfield produced more than 1 million barrels of crude. Sejita cycling plant of Trinity Gas Corp. and Hagist gasoline plant of Mobil Oil Co., Goliad Division, recovered natural gas liquids. Salt in brine was recovered from wells at Palangana sale dome by Pittsburgh Plate Glass Co. for use in manufacturing industrial chemicals at its Corpus Christi plant. Duval Quarry Co., Inc., quarried and prepared limestone for concrete aggregate and roadstone.

Eastland.—Mineral value advanced 4 percent in 1963. Gasoline plants of Mobil Oil Co., Graridge Corp., and Lone Star Gas Co. (2) recovered natural gas liquids. Fire and miscellaneous clays were mined at open pits for use as lightweight aggregate by Featherlite Corp. and Texas Lightweight Aggregate Co., for heavy clay products and brick by N. D. Gallagher Clay Products Corp., and for floor and wall tile by Texeramics, Inc. Limestone was quarried and prepared for aggregate and roadstone for Texas Highway Department.

Ector.—The county was the second ranking county in total value of minerals produced and in crude oil production. Three oilfields from 7 exploratory wells were proved; 282 development tests proved 239 oil and 16 gas wells. Five gasoline plants and one cycle plant recovered natural gas liquids. A 23-million-cubic-foot-per-day gas sweetening and dehydration plant was installed in Goldsmith/San Andres field by Andector Gas Co. Sulfur was recovered from sour gas at plants of Odessa Natural Gas Co., J. L. Parker Co., Pan American Petroleum Corp., and Phillips Petroleum Co. Sid Richardson Carbon Co. recovered carbon black from natural gas at its Odessa channel plant. Polyethylene output of the Odessa petrochemical complex was expected to rise to 120 million pounds in 1963, to 135 million pounds in 1964, and 150 to 160 million pounds by 1965, according to Rexall Chemical Co. Odessa Natural Gasoline Co., Odessa, neared completion of a plant for making anhydrous ammonia from natural gas; capacity will be 25,000 tons per year. El Paso Natural Gas Products Co. and Rexall Drug & Chemical Co. completed a 60-million-pound-per-year polypropylene plant late in 1963. A 30-million-pound-per-year polypropylene plant will be completed early in 1964.

Shell Pipe Line Co. was building a 133-mile pipeline to carry up to 600,000 gallons of brackish water from the Capitan Reef complex near Kermit in Winkler County to 28 waterflood units in Ector County. The system will serve 86 percent of Ector County wells and nearly 70 percent of the county's 152,000 barrel daily production. Companies contracting for the water were Pan American Petroleum Corp., Shell Oil Co., Humble Oil & Refining Co., Texaco, Inc., Phillips Petroleum Co., Atlantic Refining Co., Continental Oil Co., Union of California, Sunray DX Oil Co., Cities Service Oil Co., and Forest Oil Corp. Oil fields with secondary-recovery programs in operation or planned are TXL, Wheeler, Goldsmith, Andector, Andrews, N. Cowden, Johnson, Foster, S. Cowden, Harper, Penwell, and Jordan. A major new flood in the San Andres zone was being developed by Pan American Petroleum Corp. Goldsmith-Landreth unit includes 226 wells in 6,066 acres and the waterflood program added an estimated 50 million barrels to reserves. A second salt cavity for ethylene storage was being built by El Paso Natural Gas Products Co. Limestone for concrete aggregate and roadstone was quarried and prepared by Permian Sand & Gravel Co., Inc., and two other producers. Southwestern Portland Cement Co. produced limestone and clay for manufacture of cement at its Odessa plant.

Ellis.—Portland and masonry cements were produced at the Midlothian plant of Texas Industries, Inc. Miscellaneous clay was mined from open pits near Palmer by Barron Brick Co. and Acme Brick Co. and from pits near Ferris by the Ferris Brick Co. The clay was used for building and face brick, drain and sewer tile, sewer pipe, and kindred products. Limestone was quarried and crushed and paving gravel prepared by contractors for District 18 of Texas Highway Department.

El Paso.—Mineral production decreased 7 percent in value in 1963. Southwestern Portland Cement Co. quarried limestone and shale for use in portland and masonry cements at its El Paso works. Lead and copper smelters of American Smelting & Refining Co. and the Nichols copper refinery of Phelps-Dodge Refining Co. operated throughout 1963. El Paso refineries of California Oil Co., Western Division, and Texaco, Inc., together processed 91,000 barrels of crude oil a day. California Oil Co., Western Division, El Paso, completed construction involving 2,000-barrels-per-stream-day asphalt-producing capacity and 300-barrels-per-stream-day additional sulfuric-acid alkylation capacity. The 36,000-ton-per-year steel mill of Border Steel Mills, Inc., processed iron and steel scrap from the El Paso area into structural shapes and reinforcing bars. Limestone was quarried and crushed for concrete aggregate and roadstone by McMillan Quarries, Inc., Vowell Material Co., and other producers. Building and paving sand and gravel were prepared on contract for Texas Highway Department.

Fayette.—Value of minerals produced was 14 percent more than that of 1962. Development drilling added one oil and two gas wells from five tests. Bentonitic clays were mined from open pits by the Milwhite Co., Inc., and Baroid Division of National Lead Co.; fuller's earth was mined by Flatonia Fullers Earth Co. and Balcones Minerals Corp. Building and paving sand and gravel were prepared by one

producer and by contractors for District 13 of Texas Highway Department. Limestone and sandstone were prepared as concrete aggregate and roadstone by various producers.

Fisher.—Total mineral value increased 4 percent in 1963. The county ranked second in gypsum output. Two oilfields were discovered during the year and 1 gas and 27 oil wells were proved from 39 development tests. Natural gas liquids were recovered at four gas processing plants. Gypsum was mined from open pits near Longworth by Celotex Corp. and from pits near Rotan by National Gypsum Co. for preparing wallboard, lath, plaster, and other building products. Clay was recovered from open pits for cement manufacture by Lone Star Cement Corp.

Foard.—Mineral value increased 6 percent compared with 1962. The petroleum industry discovered 1 oilfield and proved 8 oil and 1 gas well from 10 development projects. Paving gravel was produced by contractors for District 25 of Texas Highway Department.

Fort Bend.—Value of mineral production approximated that of 1962. The county was third largest Frasch sulfur producer in the State. The petroleum industry discovered 1 oil and 2 gasfields and added 15 oil and 7 gas wells from 38 development wells. Industrial Gas Supply Co. recovered natural gas liquids at its Needville plant. Paving sand was produced by contractors for District 12 of Texas Highway Department. Miscellaneous clay was mined from pits near Missouri City by Texas Lightweight Aggregate Co. and by Calag Co., Inc. Evaporated and block salt was prepared from brine at the Blue Ridge works of United Salt Corp. Sulfur was recovered by Frasch process at Orchard Dome by Duval Corp. and at Long Point Dome by Jefferson Lake Sulphur Co.

Freestone.—Mineral value was 4 percent less than in 1962. One oil and 16 gas wells resulted from 20 development projects. Sandstone was quarried and crushed for concrete aggregate and riprap by East Texas Stone Co. Miscellaneous clay was mined from open pits for brick and other heavy clay products by the Teague Brick & Tile Co.

Frio.—Value of crude oil, natural gas, and natural gas liquids produced in Frio County increased 3 percent over that of 1962. Shell Oil Co. and Suburban Natural Gas Processing Co. recovered natural gas liquids from West Big Foot field. Exploratory drilling resulted in discovery of 1 oilfield; development drilling added 23 oil wells and 10 gas wells—only 2 development wells were dry holes.

Gaines.—The county ranked fifth in oil production. Thirty-six exploratory drill projects discovered 8 oilfields and 2 gasfields; 105 development projects proved 86 oil and 5 gas wells. Natural gas liquids were recovered from Seminole, West Seminole, and Russell gasfields at plants of Cities Service Oil Co. and Phillips Petroleum Co. The Seminole No. 66 channel plant of Columbian Carbon Co. recovered carbon black; sulfur was recovered from sour natural gas by Columbian Fuel Corp. Calcareous quartzite was quarried and crushed for concrete aggregate and roadstone by Elliott Taylor.

Galveston.—The county was the State's largest clay producer and was second in shell production. Miscellaneous clay was recovered by Ideal Cement Co. and Gulf Coast Portland Cement Co. for preparing cement. Horton & Horton dredged shell from shallow bays sur-

rounding the county for roadstone and manufacture of lime and cement. The petroleum industry discovered 1 new oilfield through exploratory drill projects and proved 68 oil and 6 gas wells with 98 development projects. Offshore exploration was unsuccessful. Marathon Oil Co., Texas City, increased fluid cat cracking capacity; fresh-feed capacity was increased from 16,000 to 20,000 barrels per stream day and recycle from 5,000 to 20,000 barrels per stream day. Wah Chang Corp. processed Bolivian tin ores at its Longhorn tin smelter located at Texas City. Paving sand and gravel was prepared by various contractors for District 12 of Texas Highway Department and City Engineer of Galveston. American Oil Co. completed a 600-ton-per-stream-day anhydrous ammonia plant at Texas City. Monsanto Chemical Co. completed the world's first synthetic lactic acid plant at yearend. Capacity was 10 million pounds per year; initial feed was natural gas. Union Carbide Co., Chemicals Division, was building a unit for straight-chain paraffins for soft detergents. This plant will supply feed for Institute, W. Va., facilities which will produce phenyl-n-alkanes. At Texas City and South Charleston, an additional 30 million gallons per year of ethanol will be made available through modernization over the next 3 years. Production started at the new 45-million-pound-per-year vinyl acetate monomer plant of Monsanto Chemical Co. at Texas City. Acetylene for the new unit will come from the company's other Texas City petrochemical facility and acetic acid derived from ethylene produced at the company's Chocolate Bayou plant. Alta Loma gas processing plant recovered natural gas liquids from Alta Loma field.

Garza.—Exploratory drill projects resulted in discovery of 4 oilfields and development drilling proved 47 oil wells. Garza oilfield produced more than 1 million barrels of crude oil.

Gillespie.—Value of nonmetallic minerals increased 31 percent. Dressed building stone, rough construction and architectural, curbing, and flagstone were prepared from a limestone quarry by Doebbler's Quarry. Carson Quarrying produced limestone for riprap and concrete aggregate. Building and paving sand and gravel were produced by Gilbert Gold, James Moellendorf, Alvin Usener, Weirich Bros., Inc., and Alfred E. Wunderlich. Rubble and rough architectural granite was quarried and prepared by Bear Mountain Quarries, Inc. Talc was mined from open pits by Southwestern Talc Corp. for roofing granules, filler, carriers for insecticides, and joint cement.

Glasscock.—Value of crude oil and natural gas produced advanced 3 percent. One oilfield was discovered by exploratory drill projects and 9 of 11 development tests were completed as oil wells.

Goliad.—Banquete Gas Co. recovered natural gas liquids at its Milby gasoline plant. Exploratory drill projects resulted in discovery of 2 new oilfields and 1 gasfield; development projects added 19 oil wells and 18 gas wells from 67 test wells.

Gonzales.—Mineral value was 37 percent greater than in 1962. Exploratory drilling of seven wells proved one oil well; two development wells proved one gas well. Bentonitic clays were mined from open pits by Baroid Division of National Lead Co. and Southern Clay Products, Inc., and used in heavy drilling muds. Sandstone was quarried and crushed for concrete aggregate and roadstone. Paving

gravel was prepared by contractors for District 13 of Texas Highway Department. Building and paving sand and gravel were prepared by Gonzales Gravel Co.

Gray.—Carbon black was recovered from natural gas at channel plants of Columbian Carbon Co. and from natural gas and gas liquids at Pampa furnace plant of Cabot Carbon Co. Natural gas liquids were recovered at gasoline plants of Cities Service Oil Co., Amarillo Oil Co., Kerr-McGee Oil Industries, Inc., and Phillips Petroleum Co. Six of 141 development projects were completed as gas wells and 115 as oil wells. Panhandle Gray County oilfield produced more than 10 million barrels of crude oil. Celanese Chemical Co. expanded acetyl chemical capacity of its Pampa plant through computer control programs installed at Bishop facility. Acetyl chemicals were produced from butane and pentane.

Grayson.—A quadruple oil well—20 Handy unit—was completed in the S.E. Handy area by Texaco Inc. Production occurred through perforations at 4,282 to 4,302, 4,380 to 4,400, 4,564 to 4,572, and 4,836 to 4,863 feet. Five oilfields were discovered as a result of 22 exploratory drill projects; 28 of 39 development projects were completed as oil wells. Standard Oil Co. of Texas recovered natural gas liquids at two cycle plants. Limestone was quarried and crushed for concrete aggregate, riprap, and roadstone by Crusher, Inc., and other producers. Building sand and gravel was produced by M & K Sand & Gravel Co.

Gregg.—One gasfield was discovered from 2 exploratory projects; 10 development tests added 6 gas wells and 1 oil well to oil and gas reserves of the county. Crude oil was processed at Longview refinery of Premier Oil & Refining Co. Skelly Oil Co. dismantled its 4,000-barrel-per-day Longview refinery because of equipment obsolescence. Six gasoline plants recovered natural gas liquids. Texas Eastman Co. produced polyethylene and propylene, cellulose acetate, and other petrochemical intermediates and plastic products at its Longview complex.

Guadalupe.—Eleven exploratory drill tests proved a single oil well; development drilling added 34 new oil wells from 41 tests. Darst Creek oilfield produced over 1 million barrels during the year. Miscellaneous clay was mined from open pits near McQueeney by Acme Brick Co. for building brick and tile.

Hale.—Pan American Petroleum Corp. recovered natural gas liquids from Anton-Irish field. Anton-Irish oilfield produced over 1 million barrels of crude during 1963. Development drill projects proved one oil well. Best Fertilizer Co. planned a 200,000-ton-per-year fertilizer complex at Plainview. Products would be anhydrous ammonia, ammonium phosphate, superphosphate, ammonium sulfates, and other industrial chemicals including 250 tons of sulfuric acid per day.

Hansford.—Phillips recovered natural gas liquids at its Hansford and Sherman gasoline plants and began helium recovery at its new 200-million-cubic-foot-per-day plant associated with the Sherman plant. Five oil and 15 gas wells were completed through 35 development drill projects.

Hardeman.—The petroleum industry discovered 3 oilfields with 11 exploration projects and added 19 oil and 1 gas well with 27 development tests. Shell Oil Co. completed a 17,000-gallon-per-day gasoline plant in Conley field. Bestwall Gypsum Co. mined and calcined gypsum for manufacture of wallboard, sheathing, and building plaster; output was third largest in the State.

Hardin.—The petroleum industry of the county proved 56 oil and 1 gas well through 86 development drill projects. Village Mills, East and Sour Lake oilfields each produced in excess of 1 million barrels of crude oil. Sinclair Oil & Gas Co. recovered natural gas liquids from Silsbee and Hampton South gasfields at its No. 25 gasoline plant and No. 26 cycle plant. Paving gravel was prepared by various producers.

Harris.—One new gasfield was discovered during the year; development drilling proved 83 oil and 11 gas wells with 142 projects. Four oilfields, Goose Creek, Pierce Junction, Tomball, and Webster, each produced more than 1 million barrels of crude oil. Six cycling and gasoline plants recovered natural gas liquids. Carbon black was recovered from natural gas liquids at the Eldon furnace plant of J. M. Huber Corp. Six refineries, having a total daily throughput of 765,000 barrels, processed crude oils from Texas, from adjoining States, and from foreign countries throughout the year. Sulfur was recovered from sour refinery-off-gases by Shell Chemical Co., Sinclair Refining Co., Stauffer Chemical Co., and Signal Oil & Gas Co. Humble Oil & Refining Co. at Baytown, increased sulfuric acid alkylation capacity from 20,000 barrels per stream day to 22,500. Texas Asphalt & Refining Co., Pasadena, was building a 1,500-barrel-per-stream-day cat reformer, 750-barrel-per-stream-day hydrogen treating unit, and 500-barrel-per-stream-day lube facility. At Houston, Shell Oil Co. was building a 38,000-barrel-per-day catalytic-feed hydrogen treating unit, and a 13,000-barrel-per-day depropanizer. The company was replacing main fractionator on its 57,000-barrel-per-stream-day cat cracker. The Houston steel mill of Sheffield Steel Division of Armco Steel Corp. processed Texas brown iron ores and also ores from Minnesota and Labrador.

Harris County led the State in cement production. Portland and masonry cements were produced by Ideal Cement Co., Lone Star Cement Corp., Trinity Division of General Portland Cement Co., and Gulf Coast Portland Cement Co. Barite from other States and from foreign countries was ground and prepared for heavy drilling mud by The Milwhite Co., Inc., and Baroid Division of National Lead Co. Clay used for brick and other heavy clay products was mined from open pits by Acme Brick Co., J. M. Cordell & Sons, Inc., and Houston Brick & Tile Co. Lime was manufactured from shell by Champion Papers, Inc., and Sheffield Division of Armco Steel Corp. Building and paving sand and gravel were produced by nine companies and various contractors. Houston Slag Materials Co. prepared slag from Sheffield works of Armco Steel Co. for concrete aggregate and roadstone. Salt was mined by United Salt Corp. from Hockley salt dome and was obtained as salt in brine from wells at Pierce Junction salt dome by Texas Brine Corp. Perlite, mined in other States, was expanded at the Houston plants of Perlite of Houston, Inc., and The

Tri-Lite Corp. Crude vermiculite from domestic and foreign sources was exfoliated at the Houston plants of The Tri-Lite Corp. and Vermiculite Products, Inc. U.S. Gypsum Co. continued production at its gypsum, plaster, and wallboard plant at Galena Park.

A number of chemical companies were located in Harris County, particularly in the Houston environs, including Tenneco Chemical Co., Diamond Alkali Co., Du Pont & Co., Inc., Linde Division of Union Carbide Corp., Celanese Chemical Co., Gulf Oil Corp., Phillips Chemical Co., Jefferson Chemical Co., Lone Star Chemical Co., Inc., Humble Oil & Refining Co., Texaco, Inc., Mobil Chemical Co., Monsanto Chemical Co., Amoco Chemical Corp., Dow Badische Chemical Co., and Goodyear Tire & Rubber Co., among others. A wide array of organic and inorganic chemicals, feedstocks, and intermediates were produced. Important chemicals were ammonia, acetylene and acetyl chemicals, acrylonitrile, benzene, butanol, caprolactam, ethylene, propylene, the poly derivatives, and styrene. Alamo Polymer Corp. (National Distillers & Chemical Corp. and Phillips Petroleum Co.), Deer Park (near Houston), completed a polypropylene plant. Diamond Alkali Co., Deer Park, and Pasadena, expanded polyvinyl chloride capacity to 100 million pounds per year. Gulf Oil Corp. at Brazoria, Cedar Bayou (near Houston), completed an ethylene plant earlier in the year and was building facilities for propylene and other chemicals. Tenneco Chemical Co., subsidiary of Tenneco Corp., Houston Ship Channel area, planned to complete an anhydrous ammonia plant in 1964, with capacity of about 125,000 tons per year. Scheduled for future construction are facilities for vinyl acetate monomer. Humble Oil & Refining Co. planned to make high-purity linear paraffins for soft detergents at the Baytown refinery using new separating techniques devised by Esso Research. Shell Chemical Co., Houston, neared completion of a plant for normal butyl alcohol and isobutyl alcohol. Signal Oil & Gas Co., Houston, was building a $350,000 plant for recovering 40 tons of sulfur per day from off gas. A 60-million-pound-per-year high-density polyethylene unit was added to the Houston complex of U.S. Industrial Chemical Co. The new facility is adjacent to existing low-density polyethylene unit. A polypropylene unit was also planned by the company. Methanol capacity of Deer Park plant of Rohm & Haas Co. increased from 100 to 200 tons per day. The expansion, to be completed in early 1965, would end the company's dependence on open market purchasing. Cary Chemical Co. added a 50-million-pound-per-year vinyl-resin dispersion unit to its Houston facility. Chanelview Sinclair Petrochemicals, subdivision of Sinclair Oil Corp., planned a 40-million-pound-per-year methyl ethyl ketone plant as the start of a large secondary petroleum complex to upgrade primary petrochemicals. Nucleus of this complex was the 200-million-pound-per-year butadiene plant the company bought from Texas Butadiene & Chemical Corp. in 1962. Premier Petrochemical Co. was building a 70,000-ton-per-year urea plant at Pasadena. Celanese Corp. of America continued production of linear polyethylene at its Pasadena plant. Tenneco Chemical Co. also built a 100-million-pound-per-year acetylene and 200-million-pound-per-year vinyl chloride monomer plant adjoining the Houston Ship Channel. Gulf Reduction Corp. processed metal scrap to recover and refine aluminum and zinc

ingots and alloys. Tenneco Oil Co. was building a 53,000-ton-per-year ammonia plant. Other anhydrous ammonia plants included Diamond Alkali Co. and Rohm & Haas Co., both at Deer Park.

Harrison.—The petroleum industry confirmed 38 oil and 7 gas wells from 51 development projects to add to its production and reserves. Six gasoline plants recovered natural gas liquids. Crude oil was processed at the 2,000-barrel-per-day refinery of Waskom Natural Gas Corp. Fire clay was mined from open pits near Marshall by Marshall Brick Co. and Marshall Pottery Co. for brick, other heavy clay products, stoneware, and pottery. Darco Division of Atlas Chemical Industries, Inc., mined lignite from open pits to make activated carbon at its Marshall plant. Miscellaneous stone was quarried and prepared for concrete aggregate and roadstone by various producers.

Henderson.—Three gas and 11 oil wells were completed from 19 development tests of the oil and gas industry. Natural gas liquids were recovered at the Trinidad plant of Lone Star Gas Co. A $2 million, 22-million-cubic-foot-per-day gas processing plant capable of recovering 60,000 gallons of liquids per day was activated in Fairway field by Hunt Oil Co. Casinghead gas from wells in the James Lime, Massive Anhydrite, Pettit, and Rodessa zones were processed at the plant. Opelika cycling plant of Lone Star Producing Co. was shut down in 1963. Fire clay and miscellaneous clay were mined from open pits near Athens by Athens Brick Co., Inc., Texas Clay Products, Inc., Harbison-Walker Refactories Co., and Anderson County Mining Enterprise, Inc. Most of the clay was used in making building brick and other heavy clay products. Athens Tile & Pottery Co. produced miscellaneous clay for pottery. Building and paving sand and gravel were produced by Turkey Creek Sand & Gravel Co., Malakoff Sand & Gravel Co., and Southwest Construction Materials Co.

Hidalgo.—The county was the State's fifth ranking natural gas producer. The petroleum industry discovered 1 oil and 5 gasfields from 19 exploration projects; 33 development tests proved 1 oil and 23 gas wells. Crude oil was processed at La Blanca refinery of Permian Corp. and at Donna refinery of Delta Refineries. Natural gas liquids were recovered at plants of Clark Fuel Producing Co., Pan American Petroleum Corp., Anchor Gasoline Corp., and Delhi Taylor Oil Corp. Building brick was manufactured from miscellaneous clay mined by Valley Brick & Tile Co. Limestone was quarried and crushed for concrete aggregate and roadstone by Heldenfels Bros. Building and paving sand and gravel were produced by The Fordyce Co. and various producers.

Hockley.—Natural gas liquids were recovered at four gasoline plants, one of which—Western Natural Gas Co.—was acquired by Sinclair Oil & Gas Co. Sulfur was recovered at the Slaughter gas processing plant of Pan American Petroleum Corp. The petroleum industry confirmed 33 oil wells and 1 gas well with 37 development tests.

Hopkins.—Humble Oil & Refining Co. recovered natural gas liquids at its Pickton gasoline plant. Fire clay was mined from open pits for fire brick and refractory shapes by A. P. Green Fire Brick Co., Sulphur Springs Division.

Howard.—Exploratory drill projects discovered 1 oilfield, and 99 oil wells were completed from 121 development tests. Three oilfields,

Howard Glasscock, Iatan East Howard, and Snyder, each produced more than 1 million barrels of crude. Limestone was quarried and prepared for concrete aggregate and roadstone by various producers. Cosden Petroleum Corp. processed crude oil at its Big Spring refinery. Carbon black, from natural gas liquids, was recovered at furnace plants of Cabot Carbon Co. and Sid Richardson Carbon and Gasoline Co. Natural gas liquids were recovered from E. Vealmoor field by Reef Corp. Building sand and gravel was prepared by R. E. Janes Gravel Co., Inc., and West Texas Sand & Gravel Co.

Hudspeth.—Total value of mineral production increased 43 percent as compared with that of 1962. Gypsum was recovered from open pits near Finlay for use in cement by Southwestern Portland Cement Co. Contractors produced building and paving sand and gravel for District 24 of Texas Highway Department. Rhyolite was quarried and prepared for riprap, concrete aggregate, roadstone, railroad ballast, and roofing granules by Gifford-Hill & Co., Inc. Talc was recovered from open pits by Lone Star Talc Corp., Pioneer Talc. Co., Inc., Sierra Talc Co., Southern Clay Products, Inc., Southwestern Talc Corp., and Westex Talc Corp. Other mining companies were prospecting and developing talc deposits in the area.

Hutchinson.—Development drilling resulted in completion of 93 oil and 23 gas wells. Panhandle Hutchinson County oilfield produced more than 1 million barrels of crude during the year. Natural gas liquids were recovered at eight gasoline plants with a new 100-million-cubic-foot-per-day plant under construction by Mapco Production Co. Carbon black from natural gas liquids was recovered at three furnace plants of Phillips Chemical Co. and from natural gas at one channel and furnace plant of J.M. Huber Corp. Phillips Chemical Co. produced butylenes, propylene, butadiene, and other chemicals at its Plains butadiene plant and butadiene-styrene and poly-butadiene-type rubber at its copolymer plant near Borger. Crude oil was refined at the Borger refinery of Phillips Petroleum Co. Building and paving sand and gravel were prepared by Tri-City Sand & Gravel Co. Limestone for riprap and concrete aggregate was quarried and prepared by H. B. Zachry Co. and various producers.

Irion.—Exploratory drilling resulted in discovery of two oilfields; three development projects were completed as oil wells. Natural gas liquids were recovered at Mertzon gasoline plant of Mertzon Corp. Plant capacity was expanded to 15 million cubic feet per day with recovery of 27,000 gallons per day of liquids. Sinclair Oil & Gas Co. was building a 2.6-million-cubic-foot-per-day processing plant in Ketchum Mt. field.

Jack.—Exploratory drill projects resulted in discovery of 7 oil and 2 gasfields; 115 development projects added 59 oil and 12 gas wells to county reserves. Atlantic Refining Co. recovered natural gas liquids. Bryson Pipeline & Refining Co. processed crude oil at its 2,100-barrel-per-year Bryson refinery.

Jackson.—Four oilfields and 5 gasfields were proved with 50 exploratory wells; 84 development wells added 38 oil wells and 25 gas wells. West Ranch/41–A Zone field and West Ranch/98–A Zone, each produced in excess of 1 million barrels of crude oil. Natural gas liquids were recovered at four gasoline plants. Francitas Gas Co. shut down

747–416—64——68

its cycling plant in Francitas field. Paving sand and gravel was prepared by contractors for District 13 of Texas Highway Department.

Jasper.—Three oilfields and one gasfield were discovered during the year. Natural gas liquids were recovered from W. Buna field by Gulf Oil Corp. Miscellaneous clay was mined by Texas Portland Cement Co. Paving gravel was produced by one producer.

Jefferson.—Two oil and 2 gasfields were discovered; 44 oil and 5 gas wells were proved from 86 development tests. Stowell oilfield produced more than 1 million barrels of crude oil. Ten gas processing plants of seven companies recovered natural gas liquids. Petro Gas Producing Co. acquired the Groves processing plant of Texas Petro Gas Co. then expanded capacity to 6 million cubic feet per day. Six refineries were processing crude oil. Mobil Oil Co. at Beaumont increased lube-producing capacity from 7,500 to 8,100 barrels per stream day. Atlantic Refining Co., Port Arthur, boosted crude-charge capacity from 65,000 to 87,000 barrels per stream day. Also completed in March was a 22,500-barrel-per-stream-day hydrotreating unit for middle distillate. E. I. du Pont de Nemours & Co., Inc., Beaumont, completed a synthetic rubber plant; feedstock for plant was ethylene and propylene. Jefferson Chemical Co., Inc., Port Neches, built facilities for 150 million pounds per year of ethylene oxide. The fluid cat cracking operation at Port Arthur refinery of Texaco, Inc., will be automated with a Thompson Ramo Wooldridge 300. The catalytic "poly" gasoline unit of the refinery was computer controlled 4 years ago. The company made a 25,000-pound-per-day expansion to the crude vacuum-pipe still of its Port Arthur refinery. Pure Oil Co. added a 20-million-gallon-per-year cyclohexane unit using VOP process to its Smiths Bluff refinery. Mobil Chemical Co. added a unit to its Beaumont Chemical plant to produce terepthalic acid by a new oxidation process acquired from Olin Mathieson Chemical Corp. Other novel oxidation processes for converting aromatic hydrocarbons into intermediates were obtained. Jefferson Chemical Co., Inc., was building a second ethylene oxide unit at its Port Neches facility—150 million pounds per year. Another unit will combine the oxide with alcohols such as methanol, ethanol, and butanol to form glycol ethers. Principal uses are surface coatings, anti-icing additives, hydraulic brake fluids, plasticizers, glass and metal cleaners, and cutting oils. Gulf Oil Corp. produced alpha olefins by ethylene polymerization process at its Port Arthur refinery. Goodyear Chemical Division added a $20 million, 20,000-ton-per-year, cis 1, 4 polyisoprene unit to its Beaumont synthetic rubber plant. Pittsburgh Plate Glass Co. acquired the Houston Chemical Co. Beaumont plant with 80 million pounds per year ethylene oxide and 100 million pounds per year tetraethyl and tetramethyl lead capacity.

Miscellaneous clay was mined from open pits and used for brick and other heavy clay products by Beaumont Brick Co., Inc. Building and paving sand and gravel were prepared by C. A. McKinley Sons, Inc., and various producers. Salt in brine was recovered from wells at the Gladys City plant of Texas Brine Corp. Texas Gulf Sulphur Co. mind sulfur by Frasch process at its Fannett Dome and Spindletop Dome; output was second largest in State. Sulfur was also recovered from sour crude and casinghead gas at Port Arthur plant of Gulf Oil

Corp., Beaumont plant of Olin Mathieson Chemical Corp., and Atreco plant of The Atlantic Refining Co.

Jim Hogg.—Two oilfields and 4 gasfields were proved with 31 exploratory tests and 15 oil and 5 gas wells from 28 development tests. Atlantic Refining Co. recovered natural gas liquids from N. E. Thompsonville field.

Jim Wells.—Twenty-seven exploratory drill projects discovered 1 oil and 5 gasfields and 55 development tests proved 11 oil and 16 gas wells. Gasoline plants of Mobil Oil Co. and Sun Oil Co. recovered natural gas liquids.

Johnson.—Texas Lime Co. quarried limestone for lime, mineral food, railroad ballast, riprap, aglime, and other uses. The lime was used for agricultural, chemical, and industrial purposes, and for building plasters. Aggregate Producers, Inc., and various producers prepared paving sand and gravel.

Jones.—Five oilfields were discovered from 47 exploratory projects and 59 gas wells were completed from 96 development tests. The county's one oil refinery at Hawley was shut down by Cosden Oil & Chemical Co. Natural gas liquids were recovered from Wimberley field by Union Texas Petroleum Division of Allied Chemical Corp. R. E. Janes Gravel Co., Inc., produced building and paving sand and gravel. Limestone for use as rough architectural stone was quarried and prepared by West Texas Stone Co.

Karnes.—Exploratory drilling for oil and gas was unsuccessful but 14 oil wells and 10 gas wells resulted from 34 development tests. Susquehanna-Western, Inc., mined uranium ore from several open pits and processed the ore at its mill near Falls City. Three gasoline plants recovered natural gas liquids. Sulfur was recovered at Person plant of Shell Oil Co. and Fashing plant of Warren Petroleum Corp. The 20-million-cubic-foot-per-day refrigeration-absorption plant of Shell Oil Co. was placed in operation in the Person field; recovery included 32,000 gallons per day propane, LP gas, and natural gasoline. A new gas sweetening plant using hot potassium carbonate solution to remove H_2S and CO_2 from gas with up to 9 percent acid content was completed at Kenedy for Brown & Schoff, Inc.

Kaufman.—Four oil wells were completed from four development tests. Limestone was quarried and prepared for concrete aggregate and roadstone by Wesco Materials Corp. and by various producers for District 18 of Texas Highway Department.

Kenedy.—Humble Oil & Refining Co. recovered natural gas liquids at its Julian Pasture cycle plant. Eleven exploration projects proved 4 gasfields and 30 development projects proved 21 oil and 7 gas wells.

Kent.—Exploratory drilling resulted in discovery of 4 oilfields; 12 oil wells were completed from 19 development tests. Cogdell area and Salt Creek oilfields produced in excess of 1 million barrels each of crude oil. Building sand and gravel was prepared by Senn Gravel Co.

Kleberg.—There were four oil and five gasfields discovered. Natural gas liquids were recovered at May gasoline plant of Cities Service Oil Co., Chevron plant of Standard Oil of Texas and King Ranch cycling plant of Humble Oil & Refining Co. Humble planned to expand the

cycle plant from 777 million to 1,725 million cubic feet per day and liquid recovery by 593,000 gallons per day. Limestone (caliche) was quarried and prepared for concrete aggregate and roadstone by Heldenfels Bros.

Lampasas.—Value of mineral production of stone and sand and gravel increased over 200 percent. Limestone was quarried and prepared for concrete aggregate and roadstone. The Lampasas Sand & Gravel Co. prepared building sand and gravel during the year.

Lavaca.—Three gasfields were discovered by exploration drilling; 2 oil wells and 9 gas wells were added by 13 development drill projects. Natural gas liquids were recovered at four gasoline plants of Mobil Oil Co., San Jacinto Gas Processing Corp., Shell Oil Co., and Transcontinental Gas Pipe Line Corp. Paving sand and gravel and crushed limestone were prepared on contract for District 13 of Texas Highway Department. Sandstone was quarried and crushed for concrete aggregate by various producers.

Leon.—Samedan Associates, Inc., were building a 16-million-cubic-foot-per-day plant to process gas from various fields. Three gasfields were discovered during the year; 24 oil wells and 3 gas wells resulted from 32 development tests. Limestone was quarried and prepared for aggregate and roadstone by various producers.

Liberty.—Eight exploratory drill projects proved 1 gasfield; 101 development projects added 68 oil wells. Liberty, South, and Hull oilfields each produced more than 1 million barrels of crude oil in 1963. Sinclair Oil and Gas Co. planned a 20-million-cubic-foot-per-day refrigeration-absorption plant near Hull to recover 23,000 gallons per day of liquid from gas from Hull, Merchant, and other fields. Natural gas liquids were recovered by Humble Oil & Refining Co. and Southwest Industries, Inc. Sulfur was mined by Frasch process at Moss Bluff Dome by Texas Gulf Sulphur Co. Building and paving sand and gravel were prepared by Texas Construction Material Co.

Limestone.—One oilfield and one gasfield were discovered. Barron Brick Co. and General Portland Cement Co. mined clay from open pits for cement, building brick, and other heavy clay products. Limestone was quarried and crushed by various producers.

Live Oak.—Exploratory drilling proved 3 new oilfields and 3 new gasfields—development drilling proved 6 oil and 15 gas wells. Humble Oil & Refining Co. and Mobil Oil Co. recovered natural gas liquids. Crude oil was refined by Three Rivers Refinery. Uranium ore was mined from open pits by Susquehanna-Western, Inc.

Llano.—Rough monumental and construction granite was quarried and prepared by Premier Granite Quarries. One company quarried and prepared granite for riprap. Marble was quarried and prepared for terrazzo, roofing material, and paint filler by Dezendorf Marble Co. Limestone was prepared for riprap by Carson Quarrying. Graphilter Corp. quarried and prepared graphitic schist as a filter media.

McLennan.—Limestone and shale were mined from open pits by Universal Atlas Cement Division of U.S. Steel Corp. for manufacture of portland and masonry cements at its Waco plant. Miscellaneous shale was recovered from open pits for lightweight aggregate and building brick by Waco Aggregate Co. Limestone was quarried and crushed

by Fred Hall & Sons and various contractors for concrete aggregate and roadstone. Building and paving sand and gravel were prepared by C. F. Binner & Son, Southwest Construction Materials Co., Kleberg Sand & Gravel Co., and Neeley Sand & Gravel, Inc.

McMullen.—Sulfur was recovered from sour gas by Trans-Jeff Chemical Corp. Two oilfields and 2 gasfields were discovered during the year; development drilling added 13 oil wells and 4 gas wells with 35 tests. Natural gas liquids were recovered by Trans-Jeff Chemical Co. and two gas processing plants of Atlantic Refining Co.

Madison.—Two oilfields and 3 gasfields were discovered; 27 oil and 3 gas wells resulted from 33 development projects. Lone Star Gas Co. recovered natural gas liquids at its Madisonville gas processing plant. Pure Oil Co. installed a 60-million-cubic-foot-per-day gas processing and injection plant at Fort Trinidad field.

Martin.—Exploratory drilling resulted in discovery of 3 oilfields; 32 oil wells were completed from 34 development tests.

Matagorda.—Two oilfields and four gasfields were discovered during the year. Natural gas liquids were recovered at eight gas processing plants. A 500,000-barrel LP gas storage cavern was being developed in a salt dome by Seadrift Pipe Line Corp., subdivision of Union Carbide Corp. Miscellaneous clay was mined from open pits by Pal-Port Clay Products Corp. for brick and other heavy clay products. Paving sand was prepared by contractors for District 12 of Texas Highway Department. Shell was dredged from bays adjoining Matagorda County by Matagorda Shell Co., Inc.; output of shell was third largest in the State.

Maverick.—Natural gas liquids were recovered from Chittim field by Continental Oil Co. Two new gasfields were discovered; 14 oil wells and 5 gas wells resulted from 109 development tests.

Medina.—Eleven exploratory drill tests failed to prove any oil or gas discoveries, however, 75 development tests added 55 oil wells and 1 gas well. Miscellaneous clay was mined from open pits by D'Hanis Brick & Tile Co. for brick and other heavy clay products.

Menard.—Four oilfields were discovered from 42 exploration tests; 4 oil wells resulted from 12 development tests. Paving sand and gravel was prepared by Weirich Bros. Inc.

Midland.—One gasfield was discovered by 3 exploratory tests and 33 oil and 16 gas wells were completed from 52 development projects. Six gas processing plants recovered natural gas liquids. Phillips Petroleum Co. was building a 400-million-cubic-foot-per-day Azalea plant; Sinclair Oil & Gas Co. was constructing No. 34 plant at Pegasus field. Limestone was prepared for concrete aggregate and roadstone by various producers. Perlite Industries, Inc., expanded perlite for building plaster, insulation, concrete aggregate, soil conditioner, and other uses.

Milam.—Development drilling proved 37 oil wells with 42 tests. Exploratory drilling was limited to two dry holes. Lignite was mined from open pits by Industrial Generating Co. and used for fuel to generate electric power. Aluminum Company of America operated its Rockdale aluminum reduction works near full capacity during most of 1963; alumina from its Point Comfort alumina refinery supplied feed for the reduction plant. Various producers quarried and pre-

pared limestone for concrete aggregate and roadstone. Paving gravel was prepared by Curry Gravel Pit.

Mitchell.—Minerals produced in 1963 advanced 2 percent. Exploratory tests resulted in discovery of two oilfields. Cosden Oil & Chemical Co. produced crude oil at its Colorado City refinery. Building and paving sand and gravel were prepared by Colorado Sand & Gravel Co.

Montague.—Ten oilfields and 1 gasfield were discovered through 43 exploratory drill projects and 106 oil and 1 gas well were completed from 151 development projects. Montague County Regular oilfield produced in excess of 1 million barrels of crude oil during the year. Bowie Gasoline Corp. of Texas recovered natural gas liquids at its Bowie gasoline plant. Sand and gravel was prepared by Sadler Sand & Gravel Co. for building and other uses. Crushed limestone and sandstone used for concrete aggregate and roadstone were prepared by contractors for District 3 of Texas Highway Department.

Montgomery.—Two gasfields were discovered and three oil wells and one gas well were completed during the year. Five gas processing plants recovered natural gas liquids from Conroe, Bender, and Fostoria gasfields. The Conroe No. 63 furnace plant of Columbian Carbon Co. recovered carbon black from gas liquids. Paving sand and gravel was produced by contractors.

Moore.—The $14-million, 600-million-cubic-foot-per-year helium extraction plant of Phillips Petroleum Co. began recovery of heluim in 1963 and shipped 70 percent helium gas to storage in the Government Cliffside field. Helium was recovered at the Government-operated Exell plant. Natural gas liquids were recovered at nine gas processing plants treating gas from West Panhandle, Texas-Hugoton, and Panhandle fields. Crude oil was processed and sulfur was recovered from sour crudes and sour natural gas at McKee plant of The Shamrock Oil & Gas Corp.; crude-charge capacity of the refinery was raised from 28,500 to 31,500 barrels per stream day. Natural gas and natural gas liquids were used at the Sunray furnace plant of Continental Carbon Co. to recover carbon black. American Zinc Co. of Illinois operated its Machovec zinc retort smelter at reduced capacity through most of 1963, treating ores and concentrates from other states and foreign countries.

Morris.—Brown iron ores were mined from open pits by Lone Star Steel Co. and upgraded at the ore mill at Lone Star for blast furnace feed. The Daingerfield steel mill continued diversification of steel products. Internal modifications to processes and equipment improved quality while reducing costs.

Nacogdoches.—Natural gas liquids were recovered from Trawick field by Humble Oil & Refining Co. Acme Brick Co. mined miscellaneous clay from open pits near Garrison for use in building brick.

Navarro.—One new gasfield was discovered; 6 oil and 3 gas wells resulted from 15 development drill projects. A $5-million ammonium phosphate plant was planned by Lone Star Producing Co. at its Trinity River chemical complex. The company was building a 92,000-ton-per-year nitrogen plant and will add a 100,000-ton ammonium phosphate plant in 1964. Water transportation will be available on the Trinity River when the proposed Trinity Canal is completed.

Whiteselle Brick & Lumber Co. mined miscellaneous clay from open pits near Corsicana for use in brick and other heavy clay products. Rockwool insulation was prepared by U.S. Gypsum Co. Limestone was quarried and crushed by various producers. Building gravel was prepared by Wesco Materials Corp. and paving gravel recovered by contractors for concrete aggregate and roadstone for District 18 of Texas Highway Department.

Nolan.—Four oilfields were discovered from 19 exploratory tests and 31 oil wells were completed. Natural gas liquids were recovered at gas processing plants of El Paso Natural Gas Co., Pan American Petroleum Corp., Sinclair Oil & Gas Co., and Claytonville Gasoline Co. Lone Star Cement Corp. quarried and prepared limestone for use in portland and masonry cements at its Maryneal plant. U.S. Gypsum Co., the State's leading gypsum producer, and Flintkote Co. mined gypsum from open pits near Sweetwater for cement retarder, soil conditioner, plaster, wallboard, lath, and other gypsum products. Hillsdale Gravel Co. prepared building and paving sand and gravel.

Nueces.—Four oil and 4 gasfields were discovered from 35 exploratory projects, and 47 oil and 26 gas wells proved from 121 development tests. American Smelting & Refining Co. continued electrolytic refining and alloying operations at its Corpus Christi electrolytic zinc plant. The plant operated below capacity due to tight zinc concentrate supplies. Acetyl chemical capacity of Bishop petrochemical plant of Celanese Chemical Co. was expanded through computer control programs; propane, butane, and isobutane are feedstocks for plant operation. Crude oil was processed at six refineries having a total daily throughput capacity in excess of 231,000 barrels. Coastal States Petrochemical Co., Corpus Christi, built a fluid cat cracking unit for 15,000-barrel-per-stream-day fresh feed and 7,500-barrel-per-stream-day recycle. The company also modernized its 1,500-barrel-per-stream-day hydrofluoric acid alkylation unit. Natural gas liquids were recovered at 12 gas processing plants. Great Southern Chemical Corp. was acquired by Pontiac Refining Corp.; operations were merged with those of Pontiac.

Building and paving sand and gravel were prepared by Heldenfels Bros. and Martin Paul Wright, Jr. Shell used for concrete aggregate, roadstone, and manufacture of lime and cement was dredged from shallow bays surrounding the county by Corpus Christi Shell Co., Inc., Heldenfels Bros., General Dredging Corp., and Matagorda Shell Co., Inc. Portland and masonry cements were manufactured from clays obtained from San Patricio County and from shell at the Corpus Christi plant of Halliburton Portland Cement Co. Lime for industrial and chemical purposes was manufactured from shell by Pittsburgh Plate Glass Co. Barite from domestic and foreign sources was ground and prepared for heavy drilling mud by National Lead Co., Baroid Division.

Oldham.—Hereford Tile & Brick Co., Inc., mined miscellaneous clay from open pits to manufacture sewerpipe. Building and paving sand and gravel were prepared by Western Aggregates, Inc., and Western Sand & Gravel Co.

Orange.—One oilfield was proved from 10 exploratory drill projects and 17 oil and 3 gas wells were added from 28 development tests.

Phillips Chemical Co. recovered carbon black from natural gas liquids at its Orange furnace plant. Firestone Synthetic Rubber & Latex Co., division of Firestone Tire & Rubber Co., added 15,000 tons per year of polybutadiene capacity to its Orange facility. Natural gas liquids were recovered by Gulf Oil Corp., Marathon Oil Co., Texas Gas Corp., and Allied Chemical Corp. Portland cement was manufactured from shell and clay at Echo cement plant of Texas Portland Cement Co., Division of Alpha Portland Cement Co.

Palo Pinto.—Lone Star Gas Co. and Southwest Gas Pipeline, Inc., recovered natural gas liquids. Two oilfields and 1 gasfield were discovered; 4 oil and 13 gas wells were added to the county reserve. Miscellaneous clay, used in building brick, sewer pipe, floor and wall tile, and other heavy clay products, was mined from open pits by Texeramics, Inc., Texas Vitrified Pipe Co., and Reliance Clay Products Co. Building and paving sand and gravel were recovered from pits by Mineral Wells Sand & Gravel Co.

Panola.—Development drilling resulted in 86 oil and 14 gas wells. Natural gas liquids were recovered at eight gas processing plants. A 40-million-cubic-foot-per-day dehydration plant was being built in the Bethany field by United Gas Pipe Line Co.

Parker.—Exploratory drilling proved 1 gasfield; development drilling completed 11 gas wells and 14 tests. Natural gas liquids were recovered at the Springtown gasoline plant of Lone Star Gas Co. Miscellaneous clay, used in brick and other heavy clay products, was mined from open pits near Bennett by Acme Brick Co. and Mineral Wells Clay Products Co. Rough dimension sandstone was prepared by Ben Roy Gholson. Limestone for concrete aggregate and roadstone was quarried by Industrial Concrete & Supply Co. and other producers. Contractors prepared paving gravel and limestone for District 2 of Texas Highway Department.

Pecos.—The State's largest wildcat discovery, the Coyanosa, proved gas in the Wolfcamp conglomerate and in Devonian and Ellenburger horizons, and by late 1963, proved reservoir limits covered 11 sections. Exploratory drilling resulted in discovery of 14 oilfields and 10 gasfields; development drilling completed 30 oil and 12 gas wells. Natural gas liquids were recovered at six gas processing plants. One company quarried and crushed limestone for concrete aggregate and roadstone. Portable Aggregates, Inc., prepared paving gravel.

Polk.—Gulf Oil Corp. recovered natural gas liquids from Segno field. Special industrial sand was recovered from pits near Corrigan and prepared by Texas Construction Material Co. Various producers prepared crushed sandstone for aggregate and roadstone.

Potter.—Helium was produced and refined at the Government-owned plant near Amarillo. Natural gas liquids were recovered at Fain and Turkey Creek gasoline plants of Amarillo Oil Co. Crude oil was processed at the Amarillo refinery of Texaco, Inc. American Smelting & Refining Co. operated its Amarillo zinc retort smelter at reduced capacity through most of 1963. Zinc concentrates and ores from Western States and foreign countries were smelted during the year. Building and paving sand and gravel were recovered and processed from pits near Amarillo by Panhandle Gravel, Inc., and Texas Sand

& Gravel Co., Ltd. Pilot runs were made at the new Bushland cement plant of Southwestern Portland Cement Co.

Reagan.—Three oilfields were discovered. Natural gas liquids were recovered at three gasoline plants. Sulfur was recovered by modified Claus process from sour gas at the Barnhart plant of Northwest Production Corp.

Reeves.—Four oilfields and 1 gasfield were discovered; 53 oil and 2 gas wells were completed from 71 development projects. Tunstill gasoline plant of Phillips Petroleum Co. and Ramsey gasoline plant of Continental Oil Co. recovered natural gas liquids. F. M. Reeves & Sons, Inc., prepared building sand and gravel. Limestone was prepared for concrete aggregate and roadstone by various producers.

Refugio.—Two oilfields were discovered by exploratory drilling; 52 oil wells and 18 gas wells were proved from 87 development tests. Three gasoline plants of Hunt Industries, Pan American Petroleum Co., and Humble Oil & Refining Co. recovered natural gas liquids.

Roberts.—Exploratory drilling by Union Oil Co. proved the Morrison Ranch/L. Morrow gasfield. Transwestern Pipeline Co. recovered natural gas liquids at its Cree-Flowers gas processing plant.

Runnels.—The petroleum industry proved 14 oilfields and 2 gasfields through exploratory drill projects and completed 65 oil and 4 gas wells to add to reserves. Ft. Chadbourne oilfield produced more than 1 million barrels of crude during the year. Gas processing plants of Allied Chemical Corp. and Warren Petroleum Corp. recovered natural gas liquids.

Rusk.—One oilfield and 2 gasfields were discovered; 22 oil and 7 gas wells were completed. Natural gas liquids were recovered at gas processing plants of Humble Oil & Refining Co., The Parade Co., United Gas Pipe Line Co., Sinclair Oil & Gas Co. Fire clay, used in building brick, firebrick, and other heavy clay products, was mined from open pits near Henderson by Henderson Clay Products Co. and Major Brick Co.

San Patricio.—A total of 6 oilfields and 5 gasfields were discovered; 45 oil and 23 gas wells were proved from 97 development wells. Natural gas liquids were recovered at eight gas processing plants. Crushed limestone (caliche) was quarried and prepared for concrete aggregate and roadstone by Claude Hughes and Heldenfels Bros. Building and paving sand and gravel were prepared by various companies. Halliburton Portland Cement Co. prepared miscellaneous clay for use in cement. Sherwin alumina plant and San Patricio aluminum reduction works of Reynolds Metals Co. operated near capacity throughout the year.

Schleicher.—Production of mineral fuels was limited to crude oil, natural gas, and natural gas liquids. Two gasfields were discovered during the year and development projects proved four oil and two gas wells. Sinclair Oil & Gas Co. recovered natural gas liquids at its No. 23 gasoline plant.

Scurry.—The county ranked fourth in oil production. Exploratory drill projects proved 3 oilfields; 37 oil wells were completed from 42 development tests. Four gasoline plants recovered natural gas liquids. Miscellaneous clay was mined from open pits for use in brick and other heavy clay products by Southwestern Brick & Tile Co. Various

producers prepared limestone and sand and gravel for concrete aggregate and roadstone.

Shackelford.—A total of 9 oilfields and 1 gasfield was proved through 56 exploratory drill projects; 115 oil wells were completed from 246 development tests. Shackelford County Regular oilfield produced more than 1 million barrels of crude during the year. Natural gas liquids were recovered by Marshall Young Drilling Co.

Smith.—Three oilfields were discovered and seven oil wells completed. Chapel Hill gasoline plant at Etexas Producers Gas Co. recovered natural gas liquids. Tyler refinery of La Gloria Oil & Gas Co. processed crude oils. Miscellaneous clay, used in brick and other heavy clay products, was mined from open pits by Reliance Clay Products Co. Industrial sand was processed by H. J. Ellis Sand Co.

Starr.—Two oilfields were discovered by 24 exploration tests and 24 oil and 16 gas wells proved from 66 development tests. Five gas processing plants recovered natural gas liquids. Pumicite was prepared for carriers for insecticides and for concrete admixtures by Pozzolana, Inc. Rio Clay Products Co., division of Pozzolana, Inc., mined miscellaneous clay from open pits for use in building brick.

Stephens.—Four oilfields and 7 gasfields were discovered; 26 oil and 4 gas wells resulted from 52 development tests. Five gasoline plants recovered natural gas liquids. Building sand and gravel was obtained from open pits by Taylor Brothers. Various producers prepared limestone for concrete aggregate and roadstone for District 23 of Texas Highway Department.

Stonewall.—Exploratory drilling resulted in discovery of 3 oilfields; 47 oil wells were completed from 53 development projects. Cities Service Oil Co. recovered natural gas liquids at its Stonewall gasoline plant. Building and paving sand and gravel were recovered from open pits by R. E. Janes Gravel Co., Inc.

Tarrant.—Crude oil was processed at Ft. Worth refinery of Premier Oil Refining Co. of Texas. Limestone was quarried and crushed for use in portland and masonry cements by General Portland Cement Co. Limestone for building purposes was quarried and dressed by Carruthers Cut Stone Co.; crushed limestone was prepared by various producers. Building and paving sand and gravel were prepared by 12 producers. Western Mica Co. ground and prepared mica for use in roofing, well drilling, and joint cement. Sil-Flo Corp. expanded perlite for use as a filter aid.

Taylor.—Nine oilfields were discovered; 76 oil wells and 4 gas wells were completed from 109 development projects. Taylor County Regular oilfield produced in excess of 1 million barrels of crude oil during the year. Crude oil was processed at the Abilene refinery of Debco Corp. of Texas. Natural gas liquids were recovered by Gulf Central Oil & Gas Co. and Valera Oil Co. Abilene Brick Co. mined miscellaneous clay from open pits for use in building brick. Limestone was quarried and prepared for concrete aggregate and roadstone by H. B. Zachry Co. and by various contractors for District 8 of Texas Highway Department. Building and paving sand and gravel were prepared by Atlas Sand & Gravel Co., R. E. Janes Gravel, Inc., and Caton Sand & Gravel Co.

Terry.—Adair oilfield produced more than 1 million barrels of crude oil during the year. Natural gas liquids were recovered at Adair gasoline plant of Amerada Petroleum Corp. and Wellman plant of Chillgas Corp. Seagraves No. 64 furnace plant of Columbian Carbon Co. recovered carbon black from natural gas liquids. Sodium sulfate was recovered from brines at the Brownfield plant of Ozark-Mahoning Co.

Throckmorton.—Exploratory drilling resulted in discovery of 13 oilfields; 91 oil and 1 gas well were completed from 175 development drilling projects. Throckmorton County Regular oilfield produced in excess of 1 million barrels of crude oil during the year. Building and paving sand and gravel and crushed limestone were prepared on contract for District 3 of Texas Highway Department.

Tom Green.—Five oilfields and 2 gasfields were discovered and 16 oil wells were completed. Midland Petrochemical Co. and Service Gas Products Co. recovered natural gas liquids. Building and paving sand and gravel were prepared by Montgomery Sand & Gravel Co. and other producers.

Upton.—Four oilfields and 4 gasfields were discovered and 101 oil wells and 2 gas wells were completed from 114 development projects. Eight gasoline plants recovered natural gas liquids. Sinclair Oil & Gas Co. completed a 5.9-million-cubic-foot-per-day processing plant in Wilshire field late in 1963.

Uvalde.—Native asphalt was quarried and prepared for road surfacing material and railroad ballast from pits near Dabney by White's Uvalde Mines and from pits near Blewett by Uvalde Rock Asphalt Co. Southwest Stone Co. quarried and prepared basalt for concrete aggregate, roadstone, filter media, and rockwool. Building sand and gravel was prepared by D & D Gravel Co.

Van Zandt.—Exploratory drilling resulted in discovery of one oilfield and development drilling proved four gas wells. Van oilfield produced more than 4 million barrels of oil during 1963. Pan American Petroleum Corp. and Pure Oil Co. recovered natural gas liquids. Pan American Petroleum Corp. planned a $9-million plant to recover 9 long tons of sulfur per day and 160 barrels of liquids per day in Edgewood and N. E. Edgewood fields. Morton Salt Co. recovered rock salt from underground mines and salt in brine from wells near Grand Saline. Fire clay for floor and wall tile was produced by Anderson County Mining Enterprises, Inc.

Victoria.—Three oilfields and 5 gasfields were proved from 39 exploratory drill tests: development drilling proved 20 oil wells and 38 gas wells with 97 tests. E. I. du Pont de Nemours Co., Inc., was building an 80,000-ton-per-year synthetic ammonia plant at its Victoria chemical complex. Building and paving sand and gravel were prepared from pits by Heldenfels Bros. and various producers. Contractors prepared paving sand for District 13 of Texas Highway Department.

Waller.—Humble Oil & Refining Co. received natural gas liquids at its Katy cycling plant. Paving sand was prepared for District 12 of the Texas Highway Department; Waller County Road and Bridge Department recovered sand and gravel from Brazos River for road construction.

Ward.—Two oilfields and 2 gasfields were discovered; 123 oil and 10 gas wells resulted from 173 development tests. Ward/Estes, North

field produced over 16 million barrels of crude oil during 1963. El Paso Natural Gas Products Co. closed its refinery at Wickett. Natural gas liquids were recovered at five processing plants. Sodium sulfate was recovered from salt wells and dry-lake brines at the Monahans plant of Ozark-Mahoning Co. Salt in brine was recovered by Montex Chemical Co. Permian Sand & Gravel Co., Inc., prepared building and paving sand and gravel from pits near Grandfalls and recovered gypsum from open pits near Pyote.

Webb.—Antimony ores from Mexico were processed at the Laredo smelter of National Lead Co. Forty-two exploration projects discovered 3 oilfields and 2 gasfields; 62 development projects proved 25 oil and 7 gas wells. Natural gas liquids were recovered at Freer gas processing plant of Phillips Petroleum Co. Miscellaneous clay, used in building brick, was mined from open pits by one company. Paving gravel was prepared for the City Engineer of Laredo; building and paving sand and gravel were prepared by Aldape Sand & Gravel Co., Solis Sand & Gravel Co., and Webb Materials, Inc., of Laredo. H.B. Zachry Co. quarried and crushed limestone (caliche) for concrete aggregate and roadstone.

Wharton.—Sulfur was mined by Frasch process at Boling Dome by Texas Gulf Sulphur Co., the State's principal sulfur producer. Four gasfields were discovered through 20 exploratory drill projects; 116 development tests proved 45 oil and 44 gas wells. Paving sand and gravel was prepared for District 13 of Texas Highway Department. Tidewater Oil Co. recovered natural gas liquids at its West Bernard gasoline plant.

Wheeler.—Exploratory drilling by Pan American Petroleum Corp. resulted in discovery of Mobeetie gasfield; development drilling completed 63 oil wells and 4 gas wells from 68 projects. Panhandle Wheeler County oilfield produced more than 1 million barrels of crude oil during the year. Warren Petroleum Co. recovered natural gas liquids at its McLean-28 gasoline plant. Carbon black was recovered from natural gas and natural gas liquids at Shamrock furnace plant of United Carbon Co., Inc. Sandstone was quarried and prepared for concrete aggregate and roadstone. Paving gravel was produced by various contractors for District 25 of Texas Highway Department.

Wichita.—One new oilfield was discovered and 402 oil wells completed. K–M–A and Wichita County Regular oilfields each produced in excess of 3 million barrels of crude oil. Crude oil was refined at the Wichita Falls refinery of American Petrofina Co. of Texas. Continental Oil Co. shut down its refinery. Natural gas liquids were recovered at four gasoline plants. Sandstone was quarried and crushed for concrete aggregate and roadstone and paving sand was prepared by contractors for District 3 of Texas Highway Department. Building and paving sand and gravel were prepared by a subsidiary of Gifford-Hill & Co., Inc., and by Northwest Materials Co.

Wilbarger.—Exploration projects proved 1 oilfield and 107 development projects completed 64 oil wells. Wilbarger County Regular oilfield produced in excess of 1 million barrels of crude oil during 1963. Contractors prepared paving gravel for District 3 of Texas Highway Department.

Willacy.—The petroleum industry discovered one oilfield and one gasfield and completed two oil and two gas wells. Pan American Petroleum Corp. recovered natural gas liquids from La Sal Vieja field.

Williamson.—Limestone was quarried and converted into lime by Round Rock White Lime Co. and White Stone & Lime Co. The lime was principally used for chemical and industrial purposes and building plaster. Limestone for use as rubble, rough architectural and dressed stone was quarried and prepared by Leander Limestone Corp., Texas Quarries, Inc., and other producers. Limestone was quarried and crushed by Texas Carbonate Co. and various producers for concrete aggregate, roadstone, flux, railroad ballast, soil conditioner, mineral food, and other industrial uses.

Wise.—The county ranked first in stone production. Four new oilfields and 5 new gasfields were proved by exploratory drill projects; 50 oil wells and 72 gas wells were completed. Natural gas liquids were recovered as gas processing plants of Cities Service Oil Co. and Warren Petroleum Corp. Miscellaneous clay, used in building brick, was mined from open pits near Bridgeport by Acme Brick Co. Limestone was quarried and prepared for riprap, flux, aglime, concrete aggregate, roadstone, and other uses by Bridgeport Stone Co., Gifford-Hill & Co., Inc., and Wesco Materials Corp. Contractors quarried and crushed limestone and prepared paving gravel for concrete aggregate and roadstone for District 2 of Texas Highway Department.

Wood.—The petroleum industry discovered 1 gasfield from 4 exploration tests and completed 9 oil wells and 4 gas wells with 27 development tests. Quitman oilfield produced more than 1 million barrels of crude oil during the year. Natural gas liquids were recovered at Caska gasoline plant of Caska Corp. and Hawkins gasoline plant of Humble Oil & Refining Co. Pan American Petroleum Corp. recovered 200,000 gallons of liquids per day and 80 tons of sulfur at its West Yantis plant.

Yoakum.—One oilfield was discovered by 13 exploration projects and 149 oil wells completed of 157 development projects. Prentice, Prentice/6700, and Brahaney oilfields each produced more than 1 million barrels of crude oil. Natural gas liquids were recovered at Wasson gasoline plant of Shell Oil Co. and Prentice plant of Pan American Petroleum Corp. Frontier Chemical Co. recovered salt in brine from wells near Denver City.

Young.—The petroleum industry discovered 9 oilfields and oil pays during the year and completed 132 oil wells and 3 gas wells of 208 development projects. Two processing plants recovered natural gas liquids during the year; Loving plant of Turner & West closed due to lack of field gas. Graham refinery of Gratex Corp. was closed in 1963. Building and paving sand and gravel were prepared by Pitcock Bros.

The Mineral Industry of Utah

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Utah Geological and Mineralogical Survey for collecting information on all minerals except fuels.

By Merwin H. Howes [1]

UTAH mineral-production value in 1963 was $385.5 million, $25.1 million (6 percent) less than in 1962. Of the total mineral-output value, metals accounted for $211.5 million (55 percent), a decrease of $13.3 million (6 percent) in value compared with that of 1962. Mineral-fuels production decreased $1.4 million (1 percent) in value to $136.3 million, 35 percent of the State total; whereas nonmetals decreased $10.4 million (22 percent) to $37.7 million, 10 percent of the State total.

Although copper, contributing 59 percent of the total metal-output value and 32 percent of the overall mineral-output value, was again the leading mineral commodity in the State, it decreased in value and thus was largely responsible for the drop in metal-production value. Iron, molybdenum, gold, and vanadium, in order of rank—in the metals group—also decreased in production value. Increases occurred, also in order of rank, for lead, silver, zinc, and uranium.

Output values, in order of rank, increased for petroleum, natural gas, and carbon dioxide, and decreased for asphalt (gilsonite), LP gases, natural gasoline, and coal. Petroleum accounted for 67 percent of the total value of the fuels output.

The $10.5 million (50 percent) decrease in production value for sand and gravel was greater than the total decrease for nonmetals. Decreases in values of potassium salts, lime, gypsum, and fluorspar amounted to $567,000, not quite offsetting increases in values of clays, stone, salt, cement, phosphate rock, and perlite—which totaled $765,000.

A constant-dollar series has been prepared in which the bias caused by price-level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant-dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current-dollar value by the appropriate group implicit-price deflator.

---

[1] Mining engineer, Bureau of Mines, Denver, Colo.

TABLE 1.—Mineral production in Utah [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Carbon dioxide, natural thousand cubic feet	81,920	$6	100,895	$7
Clays thousand short tons	174	1,403	[2] 125	[2] 470
Coal (bituminous) do	4,297	23,209	4,360	22,755
Copper (recoverable content of ores, etc.) short tons	218,018	134,299	203,095	125,107
Fluorspar do	399	12	247	7
Gem stones	[3]	75	[3]	75
Gold (recoverable content of ores, etc.) troy ounces	311,924	10,917	285,907	10,007
Iron ore (usable) thousand long tons, gross weight	2,630	18,242	1,881	12,900
Lead (recoverable content of ores, etc.) short tons	38,199	7,029	45,028	9,726
Lime thousand short tons	163	2,759	156	2,668
Natural gas million cubic feet	74,128	12,454	77,122	14,036
Perlite short tons	929	3	1,313	7
Petroleum (crude) thousand 42-gallon barrels	31,029	85,019	[4] 33,471	[4] 91,041
Pumice thousand short tons	28	46	28	46
Salt (common) do	311	3,349	325	3,462
Sand and gravel do	19,941	20,954	11,709	10,408
Silver (recoverable content of ores, etc.) thousand troy ounces	4,628	5,022	4,791	6,128
Stone thousand short tons	2,118	3,865	2,346	4,040
Uranium ore short tons	781,955	23,653	743,792	23,852
Vanadium do	525	[5]	382	[5]
Zinc (recoverable content of ores, etc.) do	34,313	7,892	36,179	8,321
Value of items that cannot be disclosed: Asphalt and related bitumens, barite (1962), beryllium concentrate (1963), cement, clays (fire clay and halloysite-1963), gypsum, molybdenum, natural gas liquids, phosphate rock, potassium salts, and values indicated by footnote 5		[6] 50,382		[7] 40,458
Total		[8] 410,590		385,521

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes fire clay and halloysite; included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Preliminary figure.
[5] Figure withheld to avoid disclosing individual company confidential data.
[6] Value of metals and mineral fuels, $34,749,000; value of nonmetals, $15,633,000.
[7] Value of metals and mineral fuels, $23,894,000; value of nonmetals, $16,564,000.
[8] Revised figure.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$281,293	1958	$379,850
1953	311,549	1959	372,319
1954	265,498	1960	417,389
1955	301,482	1961	411,638
1956	336,894	1962	398,449
1957	350,478	1963	368,633

Employment and Injuries.—Final employment and injuries data for 1962 and preliminary data for 1963 (excluding all mineral fuels industries except the coal and asphalt industries) compiled by the Federal Bureau of Mines are shown in table 3.

Legislation and Government Programs.—No Office of Minerals Exploration (OME) contracts were executed in 1963. During the year some activity was reported on contracts awarded in prior years to United Park City Mines Co. to explore for lead and zinc in Salt Lake, Summit, and Wasatch Counties; to Keystone Mining Co. to explore for lead and zinc in Summit County; and to Glen L. Larson to explore for lead, silver, and copper in Juab and Utah Counties.

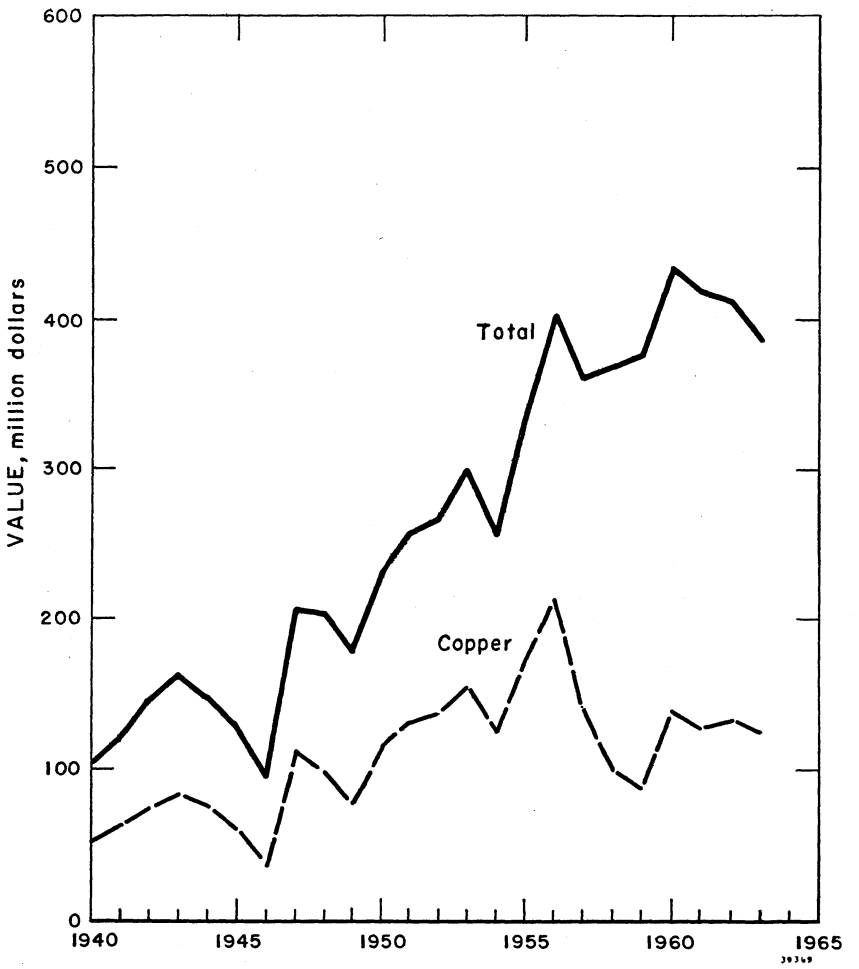


FIGURE 1.—Value of copper, and total value of mineral production in Utah, 1940–63.

747-416—64——69

TABLE 3.—Employment and injuries in the mineral industries [1]

Industry	Number of operations	Average number of men employed	Total man-hours worked	Injuries		Frequency rate (injuries per million man-hours)
				Fatal	Non-fatal	
1962:						
Nonferrous mines, mills and smelters (excluding uranium)	61	5,939	14,833,988	2	150	10.2
Uranium mines and mills	175	1,075	1,755,984	3	66	39.3
Ferrous mines and mills	11	315	620,213		7	11.3
Sand and gravel plants	127	1,042	1,837,166	1	49	27.2
Stone quarries and plants	77	484	887,891		17	19.1
Nonmetal mines and mills (other than sand and gravel and stone)	63	614	1,256,361	2	111	89.9
Coal (including cleaning plant), asphalt and related bitumens, and coke	48	2,434	3,805,104	2	96	25.6
Total	562	11,903	24,996,707	10	496	20.2
1963: [2]						
Nonferrous mines, mills and smelters (excluding uranium)	69	5,395	13,234,434	3	198	15.2
Uranium mines and mills	170	867	1,506,526	1	55	37.2
Ferrous mines and mills	10	305	528,280		5	9.5
Sand and gravel plants	162	577	959,392		15	15.6
Stone quarries and plants	64	505	1,085,949	1	16	15.7
Nonmetal mines and mills (other than sand and gravel and stone)	57	662	1,390,878	20	113	95.6
Coal (including cleaning plant), asphalt and related bitumens, and coke	50	2,071	3,274,660	10	124	40.9
Total	582	10,382	21,980,119	35	526	24.9

[1] Excludes employees in all mineral fuels industries except the coal and asphalt industries as well as office-workers.
[2] Preliminary figures.

A report [2] showed that from July 1, 1956, to December 31, 1963, Utah completed to full or acceptable interstate highway standards 78.0 miles of road plus 28.3 miles of highways adequate for present travel, for a total of 106.3 miles open to traffic. The State was ranked 45th in total miles open to traffic and 14th in total miles (410.7) of highway in progress.

A total of $58.5 million was awarded for Utah highway construction plans [3] in 1963: $43.6 million for interstate contracts, $12.2 million for Federal-Aid Primary and Secondary (ABC) contracts, and $2.7 million for State-financed contracts. The 1964 plans called for $65 million for interstate contracts, $14 million for ABC contracts, and $2 million for State-financed contracts.

Utah received $3.8 million as its share (37.5 percent) of the Federal Government collection of bonuses, royalties, and rentals during 1963 from mineral leasing on Federal lands within the State.[4]

Water.—The Bureau of Mines conducted a canvass of consumption of water in the mineral industries in 1962. Table 4 shows the data collected for the entire industry; table 5 shows, in more detail, the use of water in oil- and natural-gas-well drilling. Based on responses, the data also included estimates where necessary.

[2] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program. Dec. 31, 1963. Press release BPR 64–9, Feb. 7, 1964.
[3] Engineering News-Record. State Highway Contracts Will Rise. V. 172, No. 13, Mar. 26, 1964, pp. 13–15.
[4] Bureau of Land Management, U.S. Department of the Interior. News release, Feb. 11, 1964.

TABLE 4.—Water used during 1962 in the mineral industry, by type of operations

(Million gallons)

Type of operation [1]	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	(2)		(2)		(2)	0.14
Coal mines	995	1,399	2,394	369	626	62.98
Metal mines and mills	18,954	14,956	33,910	7,077	11,877	85.13
Nonmetal mines and mills	1,581	4,250	5,831	1,481	100	269.69
Sand and gravel operations	1,636	2,389	4,025	1,402	234	78.09
Total	23,166	22,994	46,160	10,329	12,837	
Oil- and natural-gas-well drilling			151			
Secondary-recovery operations			457			
Total			608			
Grand total			46,768			

[1] Water survey did not include cement plants, lime plants, metal smelters, metal refineries, petroleum refineries, natural-brine operations, sand and gravel operations using suction dredges without preparation plants, stockpile operations, and assessment work operations.
[2] Less than 1 million gallons.

TABLE 5.—Water used during 1962 for oil and natural gas wells drilled, by counties

County	Number of wells	Total footage drilled (feet)	Fresh water used	Saline water used	Other water used	Total water used	Total barrels per foot
			(42-gallon barrels)				
Carbon	9	28,217	21,727			21,727	0.77
Daggett	2	9,395	17,287			17,287	1.84
Duchesne	9	43,788	58,238		56,924	115,162	2.63
Emery	20	84,994	329,583			329,583	3.88
Garfield	2	10,063	21,937			21,937	2.18
Grand	51	236,739	233,746	14,830		248,576	1.05
Kane	1	9,119	13,700			13,700	1.50
San Juan	80	485,149	702,199	35,227		737,426	1.52
Sevier	1	10,740	22,551			22,551	2.10
Summit	3	8,000	11,000			11,000	1.38
Uintah	102	627,830	1,837,079		159,420	1,996,499	3.18
Utah	1	3,500	3,400			3,400	.97
Wasatch	1	6,500	14,170			14,170	2.18
Washington	3	10,454	22,790			22,790	2.18
Wayne	3	20,331	27,447			27,447	1.35
Total	288	1,594,819	3,336,854	50,057	216,344	3,603,255	[1] 2.26

[1] Average.

REVIEW BY MINERAL COMMODITIES

METALS

Beryllium.—A small quantity of beryl from Juab County was sold to Beryl Ores Co., Golden, Colo.

The acid-leach solvent-extraction process tested on Spor Mountain beryllium ore at Vitro Chemical Co. pilotplant [5] in Salt Lake City

[5] Moore, James D., and L.D. Lash. Vitro's Beryllium Pilot Plant. Min. Cong. J., v. 49, No. 7, July 1963, pp. 44–46.

was reported to be economic and competitive with or cheaper than processes using foreign beryl. Bureau of Mines tests [6] on Spor Mountain beryllium ore showed that acid leaching and solvent-extraction operations apparently were technologically feasible.

In October 1963 The Brush Beryllium Co.[7] purchased extensive beryllium-bearing ore deposits in the Topaz Mountain area from Vitro Corporation of America and Rochester & Pittsburgh Coal Co.

Continued exploration at the Spor Mountain district by The Anaconda Company [8] had developed a large reserve of beryllium ore.

Copper.—Utah, surpassed only by Arizona, was ranked second in the Nation in copper output. Output value of copper was 59 percent of that for all metals and 32 percent of the total mineral production in the State. The weighted-average price of 30.8 cents per pound for copper in 1963 was the same as in 1962. The 7-percent drop below the 1962 copper production was accounted for largely by a decrease in production by Kennecott Copper Corp.—leading producer in the State. According to the 1963 annual report of the company, 26 million tons of ore, containing 15.5 pounds of copper per ton, was mined and milled from which 197,858 tons of refined copper was produced—compared with 29 million tons of ore in 1962, containing 15.4 pounds of copper per ton from which 210,375 tons of refined copper was produced. The long-range mining plan, started in 1962, required the mining of hard and blocky areas low in content of precious metals and molybdenite and high in iron. Mining and maintenance costs were higher than normal. The high-iron content of the ore was reflected in lower grade concentrates and increased quantities of smelter slag.

Expansion of the Kennecott Utah Division leaching [9] of mine dumps was scheduled to increase the 1962 recovery of 16,678 tons to 72,000 tons of copper annually.

Other leading copper producers were United States Smelting Refining and Mining Co. (USSR&M Co.) at the U.S. and Lark mine, West Mountain mining district, Salt Lake County, and Majestic Oil & Mining Co. at the Bawana mine, Rocky mining district, Beaver County.

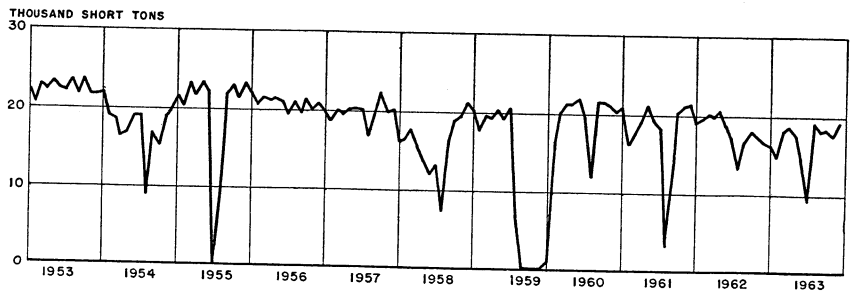


FIGURE 2.—Mine production of copper in Utah, 1953–63, by months, in terms of recoverable metals.

[6] Crocker, L., R. O. Dannenberg, and D. W. Bridges. Acid Leaching of Beryllium ore from Spor Mountain, Utah. BuMines Rept. of Inv. 6322, 1963, 15 pp.
Crocker, Laird, R. O. Dannenberg, D. W. Bridges, and J.B. Rosenbaum. Recovery of Beryllium from Spor Mountain, Utah, Ore by Solvent Extraction and Caustic Stripping. BuMines Rept. of Inv. 6173, 1963, 27 pp.
[7] The Brush Beryllium Co. Thirty-third Annual Report. 1963.
[8] The Anaconda Company. Annual Report. 1963.
[9] Argall, George O., Jr. Leaching Dumps to Recover More Southwest Copper at Lower Cost. Min. World, v. 25, No. 11, October 1963, pp. 22–27.

TABLE 6.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1954–58 (average)	69	1	28,654	389,380	$13,628	6,096	$5,517
1959	30		20,221	239,517	8,383	3,734	3,380
1960	37		28,832	368,255	12,889	4,783	4,329
1961	34		28,542	342,988	12,005	4,798	4,435
1962	25		29,981	311,924	10,917	4,628	5,022
1963	31		27,035	285,907	10,007	4,791	6,128
1864–1963	[3]	[3]	[4] 1,052,373	17,051,315	497,022	823,249	620,999

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	224,486	$150,895	45,961	$13,016	41,158	$9,666	$192,722
1959	144,715	88,855	36,630	8,425	35,223	8,101	117,144
1960	218,049	139,987	39,398	9,219	35,476	9,153	175,577
1961	213,534	128,120	40,894	8,424	37,239	8,565	161,549
1962	218,018	134,299	38,199	7,029	34,313	7,892	165,159
1963	203,095	125,107	45,028	9,726	36,179	8,321	159,289
1864–1963	8,813,172	3,570,142	5,194,650	704,859	1,621,189	299,162	5,692,184

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings, or slimes retreated and ore, old tailings, or copper precipitates shipped to smelters during the calendar year indicated.
[2] Does not include gravel washed or tonnage of precipitates shipped.
[3] Data not available.
[4] Figures estimated for certain years before 1901.

Gold.—Recovered as a byproduct from copper, lead, and zinc ores, gold production was 8 percent below that of 1962. The decline resulted chiefly from a drop in production by Kennecott Copper Corp., which led in the State output. Hecla Mining Co. at the Mayflower mine, Blue Ledge district, Wasatch County; USSR&M Co. at the U.S. and Lark mine, West Mountain district, Salt Lake County; and United Park City Mines Co. at the United Park City mine, Uintah district, Summit County and Blue Ledge district, Wasatch County were other principal gold producing companies.

Iron Ore.—Iron ore (usable) shipped was less by 749,000 long tons (28 percent) in quantity and by $5.3 million (29 percent) in value than in 1962. The major part of Utah production of iron ore came from five mines in Iron County, principally for use in making pig iron and steel. A small quantity was used in manufacturing cement. Hematite ore was mined by Columbia Iron Mining Co., a subsidiary of United States Steel Corp., at the Desert Mound and Iron Mountain mines and shipped to the company Columbia-Geneva Steel Division, Geneva. Hematite ore and concentrate produced by Utah Construction & Mining Co. at the Iron Springs mine was also shipped to Columbia-Geneva. Magnetite ore, mined under contract by Utah Construction & Mining Co. for The Colorado Fuel and Iron Corp. (CF&I) at the Blowout and Comstock mines; was shipped to the CF&I steel plant at Pueblo, Colo.

TABLE 7.—Mine production of gold, silver, copper, lead, and zinc, in 1963, by counties, in terms of recoverable metals

County	Mines producing [1] (lode)	Lode material sold or treated [2] (short tons)	Gold		Silver	
			Troy ounces	Value	Troy ounces	Value
Beaver	5	47,156	129	$4,515	65,207	$83,408
Box Elder	[3] 3	[3] [4] 64	[3] 2	[3] 70	[3] 7,916	[3] 10,125
Juab	1	71	8	280	1,281	1,639
Millard	1	5			46	59
Salt Lake	7	26,612,833	264,278	9,249,730	3,351,927	4,287,517
San Juan	([3])	([3])	([3])	([3])	([3])	([3])
Summit	4	258,672	2,735	95,725	727,003	929,924
Tooele	4	32,339	145	5,075	245,943	314,590
Utah	3	8,274	72	2,520	82,427	105,434
Wasatch	2	99,518	18,538	648,830	302,872	387,409
Washington	1	339			5,889	7,533
Total:						
1963	31	27,059,271	285,907	10,006,745	4,790,511	6,127,638
1962	25	29,980,504	311,924	10,917,340	4,628,446	5,021,865

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Beaver	899	$553,784	13	$2,765	5	$1,092	$645,564
Box Elder	[3] 687	[3] 423,162	[3] 11	[3] 2,333	[3] 6	[3] 1,231	[3] 436,921
Juab	1	862	([5])	32			2,813
Millard			2	400	([5])	46	505
Salt Lake	200,682	123,619,927	30,620	6,613,758	21,504	4,945,943	148,716,875
San Juan	([3])	([3])	([3])	([3])	([3])	([3])	([3])
Summit	172	106,291	5,605	1,210,777	6,877	1,581,779	3,924,496
Tooele	246	151,382	2,587	558,803	1,925	442,681	1,472,531
Utah	6	3,542	1,585	342,457	246	56,614	510,567
Wasatch	400	246,369	4,605	994,701	5,616	1,291,749	3,569,058
Washington	2	1,201	([5])	22	([5])	35	8,791
Total:							
1963	203,095	125,106,520	45,028	9,726,048	36,179	8,321,170	159,288,121
1962	218,018	134,299,088	38,199	7,028,616	34,313	7,891,990	165,158,899

[1] Operations at slag dumps and old mill or miscellaneous cleanups not counted as producing mines; various uranium mines from which copper was recovered as a byproduct not included as they were in the mine count of urnaium.
[2] Excludes tonnage of copper precipitates shipped.
[3] Production of Box Elder and San Juan Counties combined to avoid disclosing individual company confidential data.
[4] Excludes tonnage of uranium ore milled.
[5] Less than 0.5 ton.

Lead.—An 18-percent gain in quantity and 38 percent in value of lead production occurred in 1963. The weighted average price for lead was 10.8 cents per pound in 1963—1.6 cents higher than in 1962. Utah was ranked third in output of lead in the Nation. Much of the lead output came from the USSR&M Co. U.S. and Lark mine, West Mountain district, Salt Lake County. According to the company annual report, ore production was slightly less, but of better grade, than in 1962. Ore reserves were adequately maintained. Plans were underway to sink a new underground shaft to be started late in 1964 and to be completed in about 30 months. Other major lead-producing mines were United Park City mine of United Park City Mines Co.; Mayflower mine of Hecla Mining Co.; Ophir mine of McFarland & Hullinger, lessees, USSR&M Co.; and Tintic mine of Kennecott Copper Corp.

TABLE 8.—Mine production of gold, silver, copper, lead, and zinc, in 1963, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold-silver	1	7,035	23	505	21,900	----------	----------
Dry silver	7	159,178	1,431	272,401	135,700	5,100	4,100
Total	8	166,213	1,454	272,906	157,600	5,100	4,100
Copper	4	26,282,424	254,610	2,183,632	363,259,200	100	----------
Copper-lead-zinc and uranium [2]	[3] 3	[4] 1,081	20	33,084	1,421,800	313,400	166,900
Lead	11	6,583	105	89,013	15,200	2,878,300	226,600
Lead-zinc	10	539,125	29,700	2,202,848	3,752,500	85,981,400	67,652,600
Total	28	26,829,213	284,435	4,508,577	368,448,700	89,173,200	68,046,100
Other lode material:							
Copper precipitates	1	24,550	----------	----------	37,533,600	----------	----------
Lead cleanup	([5])	7	----------	28	----------	6,500	100
Lead-zinc cleanup and zinc slag [2]	([5])	39,282	18	8,951	50,100	870,500	4,307,100
Lead-zinc tailings	1	6	----------	49	----------	700	600
Total	2	63,845	18	9,028	37,583,700	877,700	4,307,800
Total lode material	31	27,059,271	285,907	4,790,511	406,190,000	90,056,000	72,358,000

[1] Detail will not necessarily add to totals because some mines produce more than 1 class of material.
[2] Combined to avoid disclosing individual company confidential data.
[3] Copper-lead-zinc mines only; excludes the mine count of uranium mines from which copper was recovered as a byproduct.
[4] Excludes uranium-ore tonnage.
[5] From properties not classed as mines.

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc, in 1963, by types of material processed and methods of recovery, in terms of recoverable metals

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode: Concentration and smelting of concentrates:					
Ore [1]	284,256	4,377,821	368,355,000	85,679,200	67,552,700
Cleanings	3	686	300	13,700	33,000
Total	284,259	4,378,507	368,355,300	85,692,900	67,585,700
Direct-smelting:					
Ore	1,633	403,711	251,300	3,499,800	498,100
Copper precipitates	----------	----------	37,533,600	----------	----------
Cleanings and old slag	15	8,293	49,800	863,300	4,274,200
Total	1,648	412,004	37,834,700	4,363,100	4,772,300
Grand total	285,907	4,790,511	406,190,000	90,056,000	72,358,000

[1] Includes uranium-ore concentrates.

TABLE 10.—Usable iron ore shipments

(Thousand long tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954–58 (average)	3,712	$25,411	1962	2,630	$18,242
1959	2,842	19,979	1963	1,881	12,900
1960	3,334	23,862			
1961	3,533	25,493	1906–63	68,542	313,410

Molybdenum.—Molybdenite flotation concentrate was recovered as a byproduct from copper ores mined by Kennecott Copper Corp. from its Utah Copper mine. Increased recovery was facilitated by installation of an X-ray emission gage and continuous-line recorder. Because of the highly erratic molybdenite content of the flotation machine feed, frequent adjustments in reagent feed were required to get the best recovery. The use of X-ray equipment in place of panning to determine grade changes enabled continuous and reliable on-line-molybdenite analyses to be made.

An 11-percent decline in output of molybdenum was the result of lower grade and lesser tonnage of ore mined. Utah was ranked second in the Nation in molybdenum production.

Silver.—A rise of 19.4 cents in the weighted average price per ounce of silver and an increased production of 163,000 ounces caused a 22-percent gain in value above that for 1962. Decreases in output at Utah Copper mine (largest producer in Utah) and at United Park City mine by United Park City Mines Co. were more than offset by increases in production at U.S. and Lark mine by USSR&M Co.; Mayflower mine by Hecla Mining Co.; Ophir mine by McFarland & Hullinger; Ontario dump by McFarland & Hullinger; Daly West dump by Wortley Co.; Tintic mine by Kennecott Copper Corp.; Bawana mine by Majestic Oil & Mining Co.; and Cardiff, Hirshman Estate, and Kennebec mines by Beeson Exploration.

Uranium Ore.—Despite a drop of 38,163 tons of uranium ore mined, a rise in grade from 0.35 to 0.37 percent U_3O_8 resulted in a 1-percent increase in output value. There were 240 operations in 8 counties in 1962 and 207 operations in 7 counties in 1963. San Juan County was the leading producer, having 89 percent of the State production.

Uranium processing plants were operated by Vitro Chemical Co. at Salt Lake City and Atlas Minerals Division, Atlas Corp., at Moab and Mexican Hat. On July 30, Atlas Corp.[10] purchased all of the outstanding stock of Texas-Zinc Minerals Corp., thus acquiring the Mexican Hat uranium-processing mill.

Vanadium.—The quantity of vanadium oxide recovered from certain uranium ores from Emery, Garfield, Grand, and San Juan Counties was 27 percent less than in 1962. The ores were processed by American Metal Climax, Inc., Climax Division, Climax Uranium Co., Grand Junction, Colo.; Vanadium Corporation of America (VCA), Durango and Naturita, Colo., and Shiprock, N. Mex. (the Shiprock plant was purchased from Kerr-McGee Oil Industries, Inc., on March 1); Union Carbide Corp., Union Carbide Nuclear Co. Division, Rifle and Uravan, Colo. The vanadium recovered from ores mined in Utah and processed outside the State was credited to Utah mineral production.

Zinc.—Zinc production increased 5 percent in quantity and value, compared with that of 1962. The weighted average price per pound of zinc remained at 11.5 cents. Leading producers were USSR&M Co. at U.S. and Lark mine, United Park City Mines Co. at United Park City mine, Hecla Mining Co. at Mayflower mine, International Smelting and Refining Co. at Murray slag dump, and McFarland & Hullinger at Ophir mine.

[10] Atlas Corp. 1963 Annual Report, fiscal year ended June 30, 1963.

TABLE 11.—Mine production of uranium ore, by counties [1]

County	1962				1963			
	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]
Beaver	2	[3]	[3]	[3]	1	[3]	[3]	[3]
Emery	25	33,306	163,847	$672,854	29	37,320	170,013	$682,232
Garfield	33	2,927	20,553	88,589	24	2,441	19,346	84,813
Grand	40	23,815	131,675	545,691	36	21,927	109,125	448,706
Juab	1	22,002	99,808	414,738	1	[3]	[3]	[3]
Piute	8	[3]	[3]	[3]	6	[3]	[3]	[3]
San Juan	130	678,897	5,000,163	21,654,106	110	663,833	5,160,459	22,392,045
Wayne	1	26	62	150				
Undistributed		20,982	75,898	276,726		18,271	66,756	244,020
Total	240	781,955	5,492,006	23,652,854	207	743,792	5,525,699	23,851,816

[1] Receipts at mills based on data supplied to the Bureau of Mines by AEC.
[2] F.o.b. mine value; base price, grade premiums, and exploration allowances. Calculated according to AEC Circ. 5, rev., price schedule.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

MINERAL FUELS

Asphalt and Related Bitumens.—Output value of gilsonite, mined exclusively in Uintah County, was less than half that of 1962. American Gilsonite Co. at Bonanza mines was the major producer. Other producers in order of production were Ziegler Chemical & Mineral Corp., at Little Bonanza mine; United States Gilsonite, at Workman, No. 1 and 2 mines; and Standard Gilsonite Co., at Cowboy mine.

Carbon Dioxide.—Carbon dioxide production increased 23 percent in quantity and 17 percent in value of output from that of 1962. The entire production, from wells at Farnham Dome field in Carbon County, was transported by pipeline to Wellington for conversion into dry ice and liquid carbon dioxide.

Coal (Bituminous).—Bituminous coal production from 36 mines in 6 counties increased 1 percent in tonnage from that of 1962, but decreased 2 percent in value, because the average price per ton dropped from $5.40 in 1962 to $5.22 in 1963. Carbon County accounted for 80 percent of the 4.4 million tons mined; Emery County accounted for 17 percent. Leading producers of coal were Kaiser Steel Corp. at Sunnyside Nos. 1, 2, and 3 mines; United States Steel Corp. at Columbia and Geneva mines; Independent Coal & Coke Co. at Castle Gate No. 4, Clear Creek No. 3, Kenilworth, and O'Connor No. 2 mines; and United States Fuel Co. at King mine.

Coal prospectors were active on the Kaiparowits Plateau, in southern Utah, presumably to develop coal reserves for supplying possible coal-using powerplants to supplement Glen Canyon Dam hydroelectric power.

Natural Gas.—The output of marketed natural gas increased 4 percent in quantity and 13 percent in value compared with that of 1962. From among the 7 producing counties, San Juan and Uintah Counties contributed 73 percent of the total output. Of 18 successful development-well completions, 1 was drilled in Emery County, 12 in Grand County, and 5 in Uintah County. Discovery of gas in new

fields was made in three wildcat wells—one each in Carbon, Grand, and Uintah Counties.

Natural Gas Liquids.—Natural gas liquids were recovered at plants operated by Mountain Fuel Supply Co. in Clay Basin field, Daggett County; California Oil Co., Western Division, in Red Wash field, Uintah County; and El Paso Natural Gas Co. in Aneth field, San Juan County. Output of natural gasoline decreased 11 percent in quantity and 43 percent in value; liquefied petroleum gases (butane and propane) decreased 13 percent in quantity and 42 percent in value, compared with those of 1962.

Liquids recovered from the Aneth plant of El Paso Natural Gas Co. were processed at the company fractionation plant at Wingate, N. Mex.

Petroleum.—Thirty-three million barrels of crude petroleum production from 830 wells in 7 counties resulted in an increased quantity of 8 percent and value of 7 percent from 1962 totals. Gains of more than 1 million barrels were made both in San Juan and Uintah Counties. San Juan County, largely from the Greater Aneth area, accounted for 79 percent of the total output for the State.

Petroleum producers, each with an output in excess of 1 million barrels, in order of production were Superior Oil Co., Texaco Inc., Phillips Petroleum Co., California Oil Co., Pure Oil Co., Gulf Oil Corp., Continental Oil Co., and Humble Oil & Refining Co.

Drilling declined with 90 exploratory and 120 development wells completed, compared with 110 exploratory and 174 development wells in 1962. Discoveries were made of 7 oil wells and 3 gas wells in exploratory drilling and of 60 oil wells and 18 gas wells in development drilling.

Throughput of 30.1 million barrels of crude petroleum from the following refineries was 1.8 percent less than in 1962: California Oil Co. and American Oil Co., Salt Lake City; Phillips Petroleum Co. and Caribou-Four Corners Oil Co., Woods Cross; and Beeline Refining Co. Division, Frontier Refining Co., North Salt Lake.

TABLE 12.—Coal (bituminous) production, by counties

(Excludes mines producing less than 1,000 short tons)

County	1962		1963	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Carbon	3,105,127	$5.64	3,492,950	$5.38
Emery	1,077,249	4.71	751,628	4.47
Iron	45,742	4.72	48,261	4.74
Kane			1,260	5.05
Sevier	49,393	6.29	47,495	6.08
Summit	19,509	4.46	17,937	4.55
Total	4,297,020	5.40	4,359,531	5.22

[1] Value received or charged for coal f.o.b. mine, including selling cost. (Includes value for coal not sold but used by producers, such as mine fuel and coal coked as estimated by producer at average prices that might have been received if such coal had been sold commercially.)

TABLE 13.—Crude petroleum production, by counties [1]

(Thousand 42-gallon barrels)

County	1962	1963 [2]	Principal fields in 1963, in order of production
Carbon	4	6	Peters Point.
Daggett	2	1	Clay Basin.
Duchesne	27	35	Duchesne.
Emery	33	21	Grassy Trail.
Grand	199	371	Salt Wash, Long Canyon.
San Juan	25,024	26,278	McElmo Creek, Aneth, Ratherford, Lisbon.
Uintah	5,740	6,759	Red Wash, Ashley Valley.
Total	31,029	33,471	

[1] Based on Utah Oil & Gas Conservation Commission county data adjusted to Bureau of Mines total.
[2] Preliminary figures.

TABLE 14.—Wildcat- and development-well completions in 1963, by counties

County	Oil	Gas	Dry	Total	Footage
Wildcat:					
Box Elder			1	1	9,000
Carbon		1	2	3	21,300
Duchesne	1		5	6	47,700
Emery			6	6	31,000
Garfield			5	5	28,800
Grand	3	1	13	17	57,700
Iron			1	1	4,400
Kane			1	1	9,100
San Juan	3		29	32	186,200
Sevier			1	1	6,300
Uintah		1	16	17	95,400
Total	7	3	80	90	496,900
Development:					
Carbon	1			1	3,500
Duchesne	2		1	3	17,900
Emery		1		1	3,900
Grand	6	12	16	34	155,000
San Juan	14		21	35	198,800
Sevier			1	1	4,000
Uintah	37	5	2	[1] 45	256,000
Total	60	18	41	[1] 120	639,100
Total all drilling	67	21	121	[1] 210	1,136,000

[1] Includes 1 service well.

Source: Oil and Gas Journal.

TABLE 15.—Oil and gas discoveries in 1963

County and field	Well	Operator	Location			Producing formation	Gross producing interval (feet)	Total depth (feet)	Initial production		Date of completion	Remarks [1]
			Section	Township	Range				Barrels oil per day	Thousand cubic feet of gas per day		
Grand County:												
Wildcat	Segundo Canyon Unit No. 2.	Pacific Natural Gas Exploration Co.	33	16 S	21 E	Morrison	9,846–9,852	9,900		1,600	Feb. 25	SIGW.
Do	Cherry Canyon Unit No. 1.	do	2	16 S	22 E	do	9,288–9,447	9,577		Unknown	Aug. 7	Do.
Do	Federal 64 Grand No. 1.	Sinclair Oil & Gas Co.	20	16 S	26 E	do	4,284–4,360	4,800		1,200	Nov. 15	GW.
Do	Gretchen State No. 1	U-Tex Oil Co	16	20 S	24 E	Entrada	1,193–1,196	1,710		2,750	Aug. 27	SIGW.
Do	Dutch Federal No. 1	George Hertzke	29	20 S	24 E	Not reported	465–475	483	6		Aug. 15	OW.
Do	Federal UTI Swanson No. 31–72.	Pumpelly-Stava, Operator.	31	20 S	24 E	Buckhorn	266–304	802		150	Nov. 5	SIGW.
Long Canyon	Long Canyon Unit No. 2.	Southern Natural Gas Co.	9	26 S	20 E	Mississippian	6,676–7,332	7,791	217		Aug. 13	OW.
San Juan County:												
Wildcat	Big Indian Unit No. 3.	Pure Oil Co	10	30 S	25 E	Paradox "B"	4,232–4,618	5,895	8.12	113	Mar. 12	SIGW.
Do	Navajo 116-No. 1	Walter Duncan	31	41 S	25 E	Desert Creek "C"	5,754–5,800	5,956	255		Nov. 3	OW.
Do	South Bluff Federal No. 1.	J. W. Holmes & L. & M. Ventures.	13	40 S	22 E	Paradox "D"	5,597–5,629	5,865	32	42.9	Aug. 27	Do.
Uintah County:												
Wildcat	Bonanza Unit No. 3	Pacific Natural Gas Exploration Co.	27	9 S	24 E	Buck Tongue	4,917–7,229	7,288		831	Oct. 15	SIGW (TA Oct. 1962)
Do	Government No. 1-13	Shamrock Oil & Gas Corp.	13	11 S	22 E	Mesaverde	3,920–5,337	5,349		6,200	May 7	SIGW.
Flat Rock	Flatrock Unit No. 2	Phillips Petroleum Co.	30	14 S	20 E	Mancos	3,790–3,820	6,792	609		Jan. 7	SIOW.
Wildcat	Sweetwater Creek Unit No. 3.	Skyline Oil Co	17	14 S	22 E	Wasatch	1,820–1,835	2,165	21	1,020	Aug. 13	SIGW.

[1] SIGW—Shut-in gas well; GW—gas well; OW—oil well; TA—temporarily abandoned; SIOW—shut-in oil well.

NONMETALS

Barite.—No barite was produced in Utah during 1963. Crude barite, shipped from Idaho and Nevada, was ground in the Salt Lake City plant of Yuba Minerals & Milling Co. (formerly Metals Disintegrating Co., Martin-Marietta Corp.) for use in well drilling.

Cement.—Quantity and value of cement production remained virtually the same as for 1962. The entire output of portland cement was produced by Ideal Cement Co. at its Devil's Slide plant in Morgan County and by Portland Cement Co. of Utah at its Salt Lake City plant. A small quantity of masonry cement also was produced at the Devil's Slide plant.

Clays.—As a result of increased production of halloysite, miscellaneous clay, and bentonite, the value of clay output was greater than that of 1962. The entire halloysite production came from the Filtrol Corp. operation at the Dragon mine in Juab County. Miscellaneous and fire clays for building brick, fire brick and block, lightweight aggregate, vitrified sewer pipe, and other clay products were produced by the following: Azome Utah Mining Co., Cedarstrom Fire Clay Co., International Pipe and Ceramics Corp., Interstate Brick Co., R. D. Wadley Clay Co., Loyd R. Stubbs, and Utelite Corp. Redmond Clay & Salt Co. produced bentonite from the Bosshardt mine in Sanpete County, and Western Clay & Metals Co. produced bentonite and fuller's earth from pits in Sevier County.

Fluorspar.—Fluorspar production decreased approximately 40 percent in quantity and value. The output, used in manufacturing steel, came from the Willden Bros. Lost Sheep mine in the Spor Mountain area of Juab County.

Gem Stones.—As in 1962, the value of gem-stone material collected was $75,000. Of the 17 reporting counties, Garfield County had by far the largest value—43 percent. Agate, agatized coral, obsidian, and petrified wood were the principal gem-stone materials collected. Bird's eye marble, dinosaur bone, fernwood, fossils, geodes, honey onyx, jasper, opalite, selenite, septarium nodules, scorodite, topaz, variscite, volborthite, wonder stone, and various mineral crystals also were collected.

Gypsum.—The quantity and value of crude gypsum produced from open-pit mines in the Sigurd area in Sevier County by Bestwall Gypsum Co. and United States Gypsum Co. were fairly comparable to those of 1962. The gypsum was processed in wallboard plants near the mines.

Lime.—Output of lime for sale or use decreased 4 percent in quantity and 3 percent in value below that of 1962. Utah Marblehead Lime Co. and The Flintkote Co., Utah Operations, U.S. Lime Division (formerly The Utah Lime and Stone Co.), both in Tooele County, were major producers in the State. Other producers were Kennecott Copper Corp., Utah-Idaho Sugar Co., The Amalgamated Sugar Co., and Lakeside Lime & Stone Co. Eighty-one percent of the lime output was quicklime; 19 percent was hydrated lime. Quicklime was used principally for concentrating copper ore, refractory material, sugar refining, and manufacturing steel. The chief use for hydrated lime was in construction work; lesser uses were in the agricultural

and chemical and other industrial industries. Twenty-seven percent of the total quantity of lime sold or used was shipped out of the State.

Perlite.—Crude perlite production increased 41 percent in quantity and 133 percent in value over that of 1962. Value per ton was $3.61 in 1962 and $5.03 in 1963. The entire output came from the Henry Shoo operation at the North Pearl Queen quarry near Milford, and was sold to Acme Lite-Wate Products, Inc., Salt Lake City, and Bestwall Gypsum Co., Sigurd. Expanded material was used in building plaster.

Phosphate Rock.—Although San Francisco Chemical Co. increased production at its Cherokee unit in Rich County and decreased production at its Vernal unit in Uintah County, quantity and value of production remained virtually the same as those for 1962. Again, as in 1962, the output from the Cherokee unit was processed and sold at the company Leefe plant at Sage, Wyo.; that from the Vernal unit was processed by Western Phosphates, Inc., Garfield, and sold in Utah for agricultural and industrial purposes.

Potash.—The output of potassium salts decreased 22 percent in quantity and 20 percent in value. Standard Magnesium & Chemical Corp., purchaser of the assets of Bonneville, Ltd., was the only producer. The company planned to construct a pilot plant at the Wendover property to test the possibility of producing 48 percent magnesium chloride.

According to the 1963 annual report of Lithium Corporation of America, Inc., the company, in October, acquired an option on approximately 23,000 acres of land on the shores of Great Salt Lake, with rights to extract a wide variety of minerals from the lake brine. Long-range studies were being made of the technical and economic feasibility of an integrated chemical operation involving concentration of the brine by solar evaporation and the production of such substances as bromine, calcium, chlorides of sodium, lithium, potash, and sodium sulfate.

Plans to begin limited production of potash from the Texas Gulf Sulphur Co. new mine near Moab were disrupted by a gas explosion August 28. Under revised plans, production during the latter half of 1964 was anticipated.

Pumice.—Pumice was produced in Beaver and Millard Counties for use as concrete aggregate. Quantity and value of the output—28,000 short tons and $46,000, were the same as those of 1962.

Salt.—Salt production increased 5 percent in quantity and 3 percent in value. Ninety-seven percent of the total output came from solar evaporation of Great Salt Lake brine by Lake Crystal Salt Co., Saline, Box Elder County; Morton Salt Co., Saltair, Salt Lake County; and Leslie Salt Co., Tooele, Solar Salt Co., Grantsville, and Utah Salt Co., Wendover, Tooele County. Solar-evaporated salt was shipped to all of the western States and Canada for use in the chemical, food, livestock, and manufacturing industries. Rock salt, used principally as stock feed, was mined by Albert Poulson and Redmond Clay & Salt Co. in Sanpete County and by Poulson Brothers Salt Co. in Sevier County. The mines were situated near the Sevier-Sanpete County boundary, north of Redmond.

Sand and Gravel.—The drop of 41 percent in tonnage and 50 percent in value of sand and gravel production was caused chiefly by completion of the Glen Canyon Dam in Arizona and a smaller amount of road construction in Davis, Salt Lake, and Utah Counties. Sand and gravel used in the dam was produced in Kane County. Pit operations increased from 110 to 161—2 less commercial and 53 more Government-and-contractor pits. Counties leading in State production—each with more than 1 million tons—in order of output were Salt Lake, Davis, Utah, and Kane. The five principal commercial producers were Gibbons & Reed Co., Davis County; and Utah Sand & Gravel Products Corp., James Reed, South East Sand & Gravel, and Harper Jackson Sand & Gravel Co., Salt Lake County.

TABLE 16.—Sand and gravel production in 1963, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Beaver	652	$652	Salt Lake	3,292	$3,001
Box Elder	763	612	San Juan	240	222
Cache	249	284	Sanpete	84	79
Carbon	90	88	Sevier	40	37
Daggett	120	94	Summit	5	4
Davis	1,536	844	Tooele	124	146
Emery	247	247	Uintah	361	474
Garfield	1	1	Utah	1,359	1,131
Grand	129	158	Wasatch	6	6
Iron	311	299	Washington	203	182
Juab	(1)	(2)	Wayne	23	20
Kane	1,170	1,170	Weber	508	486
Millard	93	93			
Morgan	52	32	Total	11,709	10,408
Rich	51	46			

[1] Less than 500 tons.
[2] Less than $500.

Stone.—The increase of 5 percent in output value of stone resulted largely from an increase of crushed limestone, which constituted 80 percent of the total value of stone production. Crushed limestone was used principally for manufacturing cement and lime, and as flux in smelting and steel plants. Leading producers were Ideal Cement Co., Devil's Slide quarry, Morgan County; United States Steel Corp. (Columbia-Geneva Steel Division), Keigley quarry, Utah County; and The Flintkote Co., Flux quarry, Tooele County. Other types of stone produced, in order of value, were crushed sandstone, dimension granite, dimension sandstone, crushed granite, crushed marble, dimension limestone, and crushed miscellaneous stone. Ninety-nine percent of the granite, miscellaneous stone, and sandstone produced was used for building and road construction projects by contractors of various Government agencies. Dimension stone was used for building construction and as flagstones. Other uses for stone were crushed limestone as asphalt filler, cast stone, coal-mine dust, poultry grit, roofing material, stone sand, and terrazzo; crushed marble for precasting; and crushed sandstone for mosaic, precasting, roof granules, and terrazzo.

TABLE 17.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	999	$1,115	1,164	$1,224
Paving	402	400	166	173
Railroad ballast	(1)	(2)		
Fill	252	227	76	31
Other	22	18		
Industrial:				
Molding	(3)	(3)	9	27
Blast	(1)	1	(1)	(2)
Fire or furnace			20	20
Engine	23	44	5	14
Total	1,698	1,805	1,440	1,489
Gravel:				
Construction:				
Building	1,314	1,459	1,484	1,587
Paving	1,497	966	1,608	1,440
Railroad ballast	19	8	11	5
Fill	402	352	1,176	492
Other	40	40		
Miscellaneous	300	299	59	48
Total	3,572	3,124	4,338	3,572
Total sand and gravel	5,270	4,929	5,778	5,061
Government-and-contractor operations:				
Sand:				
Building	1,216	2,508	282	282
Paving	224	121	149	149
Fill	7	3	68	34
Total	1,447	2,632	499	465
Gravel:				
Building	3,840	7,574	1,009	951
Paving	5,821	4,830	4,057	3,746
Fill	3,563	989	366	185
Total	13,224	13,393	5,432	4,882
Total sand and gravel	14,671	16,025	5,931	5,347
All operations:				
Sand	3,145	4,437	1,939	1,954
Gravel	16,796	16,517	9,770	8,454
Total	19,941	20,954	11,709	10,408

[1] Less than 500 tons.
[2] Less than $500.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Engine sand."

TABLE 18.—Stone production in 1963, by counties

County	Short tons	Value	County	Short tons	Value
Beaver	290	$300	San Juan	300	$1,500
Box Elder	594,197	300,745	Summit	884	59,657
Cache	83,461	345,535	Tooele	293,552	890,268
Daggett	4,000	4,000	Utah	(1)	(1)
Davis	800	21,450	Wasatch	15,572	77,200
Grand	419	2,995	Washington	9	1,800
Iron	236	3,112	Undistributed	1,183,265	1,881,498
Juab	(1)	(1)			
Morgan	(1)	(1)	Total	2,345,888	4,040,305
Salt Lake	168,903	450,245			

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 19.—Stone sold or used by producers, by kinds

Year	Granite		Limestone		Marble	
	Short tons	Value	Short tons	Value	Short tons	Value
1959	1,500	$1,500	1,547,600	$2,196,400		
1960	1,200	1,200	1,702,021	2,921,737		
1961			1,621,128	2,815,852	639	$3,703
1962	159,724	336,207	[1] 1,608,466	[1] 2,862,366	[2]	[2]
1963	15,704	253,225	[1] 1,716,450	[1] 3,219,167	[2]	[2]

Year	Sandstone		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1959	1,786,186	$1,834,808	2,600	$15,700	3,337,886	$4,048,408
1960	76,158	118,615	57,500	45,312	1,836,879	3,086,864
1961	126,470	329,405	59,681	69,774	1,807,918	3,218,734
1962	335,539	624,927	14,639	41,028	2,118,368	3,864,528
1963	611,628	524,713	2,106	43,200	2,345,888	4,040,305

[1] Excludes dimension limestone; included with "Other stone."
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Other stone."

TABLE 20.—Stone sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction, short tons	7,643	$41,617	479	$11,687
Rubble, do	3,137	88,700	75	1,875
Rough architectural, cubic feet			[1]	[1]
Sawed stone, do	[2] 7,589	49,155	[3] 9,909	55,882
Dressed stone, do	[4] 2,884	4,812	[5] 15,064	208,000
Flagging, do	[6] 2,884	7,875	[1]	[1]
Other, do			[7] 5,494	13,575
Total (approximate, in short tons)	11,822	192,159	2,972	291,019
Crushed and broken stone:				
Riprap, short tons	384,152	642,416	608,884	351,666
Metallurgical, do	509,975	711,353	721,693	1,000,445
Concrete and roadstone, do	128,484	126,602	26,552	90,468
Other, do	[8] 1,083,935	[8] 2,191,998	[9] 985,787	[9] 2,306,707
Total, do	2,106,546	3,672,369	2,342,916	3,749,286
Total stone (approximate, in short tons)	2,118,368	3,864,528	2,345,888	4,040,305

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Approximately 592 short tons.
[3] Approximately 773 short tons.
[4] Approximately 225 short tons.
[5] Approximately 1,200 short tons.
[6] Approximately 225 short tons.
[7] Approximately 445 short tons.
[8] Includes stone used in asphalt filler, building chips, cement, coal dust, exposed aggregate, filter beds, landscaping, lime, pottery, poultry grit, precast products, roofing granules, stucco, and terrazzo.
[9] Includes stone used in aggregates, asphalt filler, cement, coal dust, lime, mosaic, poultry grit, precast products, railroad ballast, roofing granules, stone sand, and terrazzo.

Talc.—Crude talc, shipped from mines outside the State, was ground at the Tri-State Minerals Co. mill in Ogden for use in manufacturing paint and paper.

Vermiculite.—Vermiculite from Zonolite Co., Libby, Mont., was ground by Vermiculite-Intermountain, Inc., at Salt Lake City for acoustical uses, fill, and insulation.

REVIEW BY COUNTIES

Beaver.—The ninefold increase, from $134,914 for 1962 to $1.3 million for 1963, in total mineral output value resulted largely from State and Federal road construction, which required sand and gravel valued at $652,000, and from increased copper production from the Bawana mine, valued at slightly more than $500,000. Metals accounted for little less than one-half of the mineral output value. The output value of sand and gravel comprised most of the nonmetals production value. Other nonmetals produced were pumice for use as concrete aggregate; perlite for use in building plaster; gem-stone material, consisting of crystals and copper and pyrite specimens, valued at $1,000; and a small quantity of crushed miscellaneous stone by the Utah State Department of Highways for use in road construction.

TABLE 21.—Value of mineral production in Utah, by counties

County	1962	1963 [1]	Minerals produced in 1963 in order of value
Beaver	$134,914	$1,343,093	Sand and gravel, copper, silver, pumice, uranium ore, perlite, gold, lead, zinc, gem stones, iron ore, stone.
Box Elder	1,124,742	1,137,122	Sand and gravel, stone, lime, salt, lead, silver, gem stones, zinc, gold, copper.
Cache	690,300	(2)	Stone, sand and gravel, lime.
Carbon	18,776,366	20,251,867	Coal, natural gas, sand and gravel, petroleum, carbon dioxide.
Daggett	1,440,200	442,600	Natural gas, sand and gravel, natural gasoline, stone, petroleum.
Davis	3,086,217	865,450	Sand and gravel, stone.
Duchesne	271,900	108,200	Petroleum, natural gas.
Emery	6,080,659	4,421,634	Coal, uranium ore, sand and gravel, petroleum, vanadium, natural gas, gem stones.
Garfield	224,099	159,292	Uranium ore, vanadium, gem stones, sand and gravel.
Grand	2,628,402	3,968,491	Natural gas, petroleum, uranium ore, vanadium, sand and gravel, stone, gem stones.
Iron	18,480,257	13,430,736	Iron ore, sand and gravel, coal, stone, gem stones.
Juab	1,498,213	1,395,624	Clays, stone, uranium ore, fluorspar, gem stones, silver, copper, gold, beryllium concentrate, lead, sand and gravel.
Kane	9,124,655	1,188,440	Sand and gravel, gem stones, coal.
Millard	235,058	116,314	Sand and gravel, pumice, gem stones, lead, silver, zinc.
Morgan	(2)	(2)	Cement, stone, sand and gravel.
Piute	(2)	(2)	Uranium ore.
Rich	2,380,156	(2)	Phosphate rock, sand and gravel.
Salt Lake	182,185,923	170,992,785	Copper, molybdenum, gold, lead, zinc, silver, sand and gravel, cement, salt, stone, lime, clays, gem stones.
San Juan	[3] 103,187,094	104,629,095	Petroleum, uranium ore, natural gas, LP gases, natural gasoline, vanadium, copper, sand and gravel, silver, gem stones, stone, zinc.
Sanpete	174,756	(2)	Sand and gravel, clays, salt.
Sevier	1,328,162	1,259,561	Gypsum, coal, clays, sand and gravel, salt, gem stones.
Summit	3,888,447	4,186,780	Zinc, lead, silver, clays, copper, gold, coal, stone, sand and gravel, gem stones.
Tooele	8,512,028	7,962,874	Lime, potassium salts, salt, stone, lead, zinc, silver, copper, sand and gravel, clays, gold, gem stones.
Uintah	[3] 33,285,808	29,317,835	Petroleum, gilsonite, natural gas, phosphate rock, sand and gravel, LP gases, natural gasoline.
Utah	2,273,933	2,544,088	Sand and gravel, stone, lead, silver, clays, zinc, lime, copper, gold, gem stones.
Wasatch	1,039,482	3,652,258	Zinc, lead, gold, silver, copper, stone, sand and gravel.
Washington	99,504	192,741	Sand and gravel, silver, stone, copper, gem stones, zinc, lead.
Wayne	(2)	(2)	Sand and gravel, gem stones.
Weber	(2)	624,465	Sand and gravel, clays.
Undistributed [4]	[3] 8,439,169	11,329,650	
Total	[3] 410,590,000	385,521,000	

[1] Petroleum value is preliminary.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Revised figure.
[4] Includes some sand and gravel, clays (1962), and gem stones that cannot be assigned to specific counties and values indicated by footnote 2.

Box Elder.—Sand and gravel for building and road construction and sandstone principally for riprap were valued at $612,000 and $300,745, respectively, which together constituted 80 percent of the county mineral output value. Utah-Idaho Sugar Co. produced quicklime for sugar refining at its own plant. Solar-evaporated salt was produced by Lake Crystal Salt Co. at Saline, west of Promontory Point. Variscite and gypsum crystals were the only gem stone materials collected.

Cache.—The output of lime, sand and gravel, and stone remained virtually the same as during 1962. Limestone was used for manufacturing quicklime for refining sugar and sandstone, for road construction. Sand and gravel was used in building and road construction.

Carbon.—Bituminous coal, valued at $18.8 million (7 percent more than in 1962), was the major mineral commodity of the county; it accounted for 83 percent of the total coal-output value for the State. The increased production came from 21 mines, 2 less than were operated in 1962. Kaiser Steel Corp., United States Steel Corp., and Independent Coal & Coke Co. cumulatively produced most of the coal mined. Longwall mining [11] with a shearing machine and self-advancing powered roof supports proved to be a safe and economical system of mining at the Sunnyside mines of Kaiser Steel Corp.

A gain of $129,400, 11 percent, was made in total output value of natural gas from Nine Mile Canyon, Stone Cabin, and Clear Creek fields. Small increases were made in production values for petroleum from Peters Point field and for carbon dioxide from Farnham Dome field. Output value for sand and gravel increased from $12,700 in 1962 to $88,000.

Daggett.—Completion of the concrete pour at Flaming Gorge Dam late in 1962 caused a decrease of 89 percent in sand and gravel production and a drop of 69 percent in total mineral output value. Production of natural gas, accounting for 74 percent of total output value for the county, was produced by Mountain Fuel Supply Co. from wells in the Clay Basin field. Output increased 25 percent in value. Natural gasoline was recovered from the gas at the company plant in the Clay Basin field. Petroleum, produced as drip oil from gas wells in the field, declined in output value from $5,500 in 1962 to $2,700 in 1963. Four thousand tons of sandstone was used in road construction.

Davis.—Completion of a large part of road construction by the Utah State Department of Highways was the principal reason for the decline of 74 percent in production value of sand and gravel. Crushed sandstone, valued at $21,450, was produced by Utah Quartz & Rock, Inc., for use as cast stone, mozaic, roofing granules, and terrazzo.

Duchesne.—Because there was no production of sand and gravel with the completion of planned road construction, the county mineral output value was 60 percent less than in 1962. However, the value of petroleum (produced by Shamrock Oil & Gas Corp. at Castle Peak field and Continental Oil Co. at Duchesne field) and natural gas (produced by Humble Oil & Refining Co. at Bluebell field) increased 29 and 31 percent, respectively.

---

[11] Lindsay, L. T. Longwall Progress-Sunnyside Mines. Min. Cong. J., v. 49, No. 7, July 1963, pp. 51–52.
Ross, Don. Longwall Mining with a Shearing Machine. Min. Cong. J., v. 49, No. 3, March 1963, pp. 32–34.

Emery.—The 27-percent decline in county mineral-output value resulted largely from a 34 percent drop in value of coal produced, the major mineral commodity in the county. Emery County was ranked second only to Carbon County in State output of coal. A total of 751,628 tons of bituminous coal was mined. United States Fuel Co. at King mine, United States Steel Corp. at Geneva mine, and Minerals Development Corp. at Book Cliffs mine were the leading producers.

Uranium ore production, from 29 operations, was 37,320 tons, valued at $682,232, an increase of 12 percent in quantity and 1 percent in value over those of 1962. Principal producers were Four Corners Oil & Minerals Co. and Union Carbide Nuclear Co.

Production value of sand and gravel, used in road construction, increased substantially over that for 1962. Petroleum output by Cities Service Oil Co. from Grassy Trail field declined in value from $90,400 in 1962 to $57,100 in 1963. Value of vanadium production remained virtually the same as in 1962. Agate and dinosaur bone, valued at $1,020, were gem-stone materials collected.

Garfield.—The overall drop in production value of the county was 29 percent below that of 1962. Leading producers of uranium ore were General Utilities and Industries, Inc., Ben F. Klippel & Mike Mangus, and VCA. The county led the State in value of gem-stone material collected; agate and petrified wood were gathered in the vicinity of the Henry Mountains.

Grand.—A twofold increase in output value for natural gas and an 85-percent increase in output value for petroleum from 1962 values largely accounted for the 51-percent rise in mineral-production value. Twenty-two completions were made—3 wildcat and 6 development oil wells and 1 wildcat and 12 development gas wells. Shell Oil Co., Southern Natural Gas Co., and Texaco Inc. were leading oil producers; Sinclair Oil & Gas Co., Oil Incorporated, and Trend Oil Co. were leading gas producers.

Uranium-ore production from 36 operations (4 less than in 1962) decreased 8 percent in tonnage and 18 percent in value from 1962. Uranium-ore grade was 0.276 percent U_3O_8 in 1962 and 0.249 percent in 1963. The largest output of uranium ore came from the operations of Thornburg Mining Co., Utah Alloy Ores, Inc., Union Carbide Nuclear Co., and Climax Uranium Co. Value of vanadium production was 27 percent less than in 1962. Less building construction resulted in a 61-percent drop in sand and gravel output value. The Federal Bureau of Public Roads used 419 tons of crushed sandstone for concrete aggregate and roadstone. Gem-stone materials collected—consisting of agate, dinosaur bone, and jasper—were valued at $1,955.

Surface facilities, including mill and railroad spur at the Texas Gulf Sulphur Co. Cane Creek potash mine, were completed early in the year. Production, scheduled to start early in the fall of 1963, was delayed because of changes in some of the underground procedures following a methane explosion in August, which took 18 lives. Production was to start sometime after July 1964.

Iron.—Iron ore (comprising 96 percent of the mineral-production value for the county) was 29 percent lower in output value than in 1962. The entire production of ore from the Desert Mound and Iron Mountain mines of Columbia Iron Mining Co. and ore and concentrate

from the Iron Springs operation of Utah Construction & Mining Co. was shipped to Columbia-Geneva Steel, Geneva; ore from the Blowout and Comstock mines of CF&I was shipped to the company steel plant at Pueblo, Colo. Road construction stimulated production of sand and gravel to 311,000 tons, compared with 15,200 tons in 1962. Koal Kreek Coal Co., Tucker Coal Co., and Webster Coal Co. produced 48,261 tons of coal, valued at $228,730. Crushed miscellaneous stone for use as roofing granules and dimension sandstone for use as building stone were produced and were valued at $3,112. Utah Federation of Gem & Mineral Societies collected 1,500 pounds of agate, petrified wood, and quartz.

Juab.—Nonmetals accounted for 95 percent of the mineral-output value. The major mineral commodity of the county, halloysite, was produced by Filtrol Corp. at the Dragon mine near Eureka, for use as a catalyst in cracking oil; value of output was 20 percent more than that of 1962. Fire clay was produced by International Pipe and Ceramics Corp. at the Eureka pit. An output of crushed limestone, for use as flux and in manufacture of lime, was produced by George H. Chaffin at the Leamington quarry. Crushed sandstone for ganister was produced by General Refractories Co. at the Jericho quarry. Willden Bros. mined 247 tons of fluorspar, valued at $6,700, at the Lost Sheep mine in the Spor Mountain district. Agate, geodes, and topaz, valued at $1,738, were collected in the vicinity of Dugway Pass and Dugway Mountain. Uranium-ore production substantially decreased at the Topaz Uranium Co. Yellow Chief mine in the Topaz Mountain area. Beryl produced in the county was sold to Beryl Ores Co., Golden, Colo.

Kane.—The 87-percent drop in output value of sand and gravel from 1962, caused by completion of the Glen Canyon Dam (Ariz.), resulted in a $1.2 million mineral-production value, compared with $9.1 million in 1962. Coal, 1,260 tons, was produced by Alton Coal Mine Co. at its Alton mine. Fisher's Rancho Lodge and Rock Shop, Gemwood mines, and Charles Wood collected 22,125 pounds of gem-stone materials (petrified wood and septarium nodules).

Millard.—The discontinuance of crushed-limestone production and the 31-percent drop in sand and gravel production value resulted in a 51-percent decline in total mineral output value. Utah State Department of Highways produced 93,000 tons of sand and gravel for aggregates in paving. The output of 15,000 tons of pumice (scoria), valued at $16,000, remained the same as for 1962. Collected gem-stone materials (fossils, obsidian, and snowflake obsidian) were valued at $6,809.

Morgan.—Limestone was produced only by Ideal Cement Co. at the Devil's Slide quarry for manufacturing portland and masonry cements. Output value of the cement was 5 percent less than in 1962. Sand and gravel, the only other mineral produced in the county, decreased 81 percent in output value because of road-construction completions.

Piute.—Uranium ore, mined by VCA at mines in the vicinity of Marysville, was the only mineral produced in the county. No gold, silver, copper, lead, or zinc was produced at Bully Boy and Deer Trail mines during 1963.

Rich.—Increases were made in output of phosphate rock and sand and gravel, the two minerals produced in the county. San Francisco Chemical Co. mined phosphate rock at its Cherokee unit, east of Randolph, for processing and sale at the company Leefe plant at Sage, Wyo. All of the sand and gravel produced was used as aggregate in paving.

Salt Lake.—Value of mineral production was 44 percent of the State total; 72 percent of $171 million worth of minerals produced in the county was copper. An 8-percent decrease in copper-output value, compared with that of 1962, was the result of smaller production of copper at the Utah Copper mine of Utah Copper Division, Kennecott Copper Corp. First in output of copper, gold, and silver in both county and State, the Utah Copper mine was the only producer of molybdenum. The U.S. and Lark mine of USSR&M Co. led in production of lead and zinc, was second in production of silver and copper, and was third in production of gold. Other principal sources of gold, silver, copper, lead, and zinc output were operations of Beeson Exploration at Cardiff, Hirshman Estate, and Kennebec mines and International Smelting and Refining Co. at Murray slag dump. Uranium ore was processed at the Vitro Chemical Co. uranium mill in Salt Lake City. As a result of increased building and road construction, sand and gravel production from 37 operations—18 commercial and 19 Government-and-contractor operated pits—gained 27 percent in value, compared with that of 1962. Salt Lake County was first in the State in sand and gravel production. Leading commercial producers, having outputs of more than 200,000 tons, were Utah Sand & Gravel Products Corp., James Reed, Southeast Sand & Gravel, and Harper Jackson Sand & Gravel Co.

Output value of stone increased 30 percent from 1962. Crushed limestone was produced by Kennecott Copper Corp. at Saltair Beach for smelter flux, and by Portland Cement Co. of Utah at Parley's Canyon quarry for manufacturing portland cement; dimension granite was cut by Wilford H. Hanson Stone Quarries, Inc., for use as building stone; and crushed sandstone was produced by Aggregate Supply, Inc., at Parley's Buff quarry for use in precasting.

An 18-percent gain in output value of portland cement from 1962 was made by Portland Cement Co. of Utah at its Salt Lake City plant. Output value of solar-evaporated salt, produced by Morton Salt Co. at Saltair, increased 8 percent from 1962. The total output of quicklime by Kennecott Copper Corp. for ore processing and by Utah-Idaho Sugar Co. for sugar refining rose 1 percent above that of 1962. Miscellaneous clay was produced by International Pipe and Ceramics Corp. for manufacturing vitrified sewer pipe.

San Juan.—San Juan County continued to lead in production of petroleum, natural gas, natural gas liquids, uranium ore, and vanadium. Petroleum output from 548 wells (52 less than in 1962) in 20 established and 3 undesignated fields was 5 percent greater than in 1962. Principal fields, in order of production were McElmo Creek, Aneth, Ratherford, and Lisbon. Oil was discovered in 3 of the 32 wildcat and in 14 of the 35 development-well completions. Output of natural gas, mostly oil-well gas from the Greater Aneth area, de-

creased 8 percent from 1962 and was processed by El Paso Natural Gas Co. at the Aneth plant. Natural gas liquids (natural gasoline, butane, and propane) from this plant were transported by pipeline to the company fractionation plant at Wingate, N. Mex., for separation. Value of recovered natural gasoline and LP gases (butane and propane) dropped 43 and 42 percent, respectively, below that of 1962.

Uranium ore produced from 110 operations (20 less than in 1962) dropped 2 percent below 1962 tonnage but rose $0.7 million or 3 percent above 1962 value—0.39 percent U_3O_8 average grade of ore, compared to 0.37 percent in 1962. Eighty-nine percent of the uranium ore produced in the State came from San Juan County. Leading producers, in order of production, were Atlas Corp., Standard Metals Corp., Homestake Mining Co., and Texas-Zinc Minerals Corp. Vanadium, contained in some of the uranium ore and recovered at mills in Colorado, declined 27 percent in output value from 1962. Increased road construction required using 240,000 tons of sand and gravel, valued at $222,000, compared with 132,000 tons, valued at $71,000, in 1962. A contractor for the Federal Bureau of Indian Affairs used 300 tons of sandstone for riprap. Copper, silver, and zinc were recovered from uranium ores treated at the Atlas Corp. Mexican Hat uranium mill. Gem-stone materials (with a value of $8,235), consisting of agate, dinosaur bone, fernwood, petrified wood, and volborthite, were collected.

Sanpete.—Minerals produced were clays, salt, and sand and gravel. Redmond Clay & Salt Co. produced 5,000 tons of bentonite from the Bosshardt mine for use in pond and ditch lining and for roofing; Azome Utah Mining Co. produced 862 tons of miscellaneous clay for agricultural uses. Rock salt, principally used for stock feed, was mined by Albert Poulson and Redmond Clay & Salt Co. at mines north of Redmond. A total of 84,000 tons of sand and gravel, valued at $79,000 was used in building and road construction.

Sevier.—Output of gypsum, leading commodity of the county, remained virtually the same as in 1962. Crude gypsum was mined at open pits near Sigurd by Bestwall Gypsum Co and United States Gypsum Co. for use in manufacturing wallboard in their nearby plants. Coal production by Southern Utah Fuel Co. at Southern Utah Fuel No. 1 mine declined from 49,393 tons in 1962 to 47,495 tons. Western Clay & Metals Co. produced 1,711 tons of bentonite at Redmond for use in foundries and steelworks, for drilling mud and for water impedance; the company produced 3,167 tons of fuller's earth at Aurora for use in mineral oil filters. Rock salt, 3,349 tons, was mined north of Redmond by Poulson Brothers Salt Co. Output value of sand and gravel, used for building and road construction, was 42 percent less than in 1962. Small amounts of agate and wonder stone were collected.

Summit.—Output value of gold, silver, copper, lead, and zinc, accounting for 94 percent of county mineral production, increased 11 percent from 1962. United Park City Mines Co. at United Park City mine and Keystone Mining Co. (joint venture) at Keystone mine produced gold, silver, copper, lead, and zinc. Fluxing ore containing gold, silver, and copper was shipped from the Daly West dump by Wortley Co., and from the Ontario dump by McFarland & Hullinger.

A substantial gain in production value of miscellaneous clay resulted from construction of an expanded shale aggregate plant by Utelite Corp. near Peoa, about 40 miles east of Salt Lake City. Lightweight aggregates were produced at this plant for use in prestressed concrete beams and forms and in concrete for foundations and multistory buildings. Miscellaneous clay was produced at Henefer Clay pit for use in manufacturing vitrified sewer tile by International Pipe and Ceramics Corp. and at Henefer pit for use in making building brick by Interstate Brick Co.

Chappell Coal Co. at Chappell mine produced 17,937 tons of coal, compared with 19,509 tons in 1962.

Production of 8,192 cubic feet of sawed sandstone for building, having a value of $51,082, and 3,141 cubic feet of sandstone flagging, having a value of $8,575, were produced by Rocky Mountain Quarries (total output value was 10 percent more than in 1962). Completion of road construction jobs caused a 98-percent drop in sand and gravel production value. Only 5,000 tons was produced for use in building and road construction. A small quantity of agatized coral was collected at Riley's Canyon by Golden Spike Gem & Mineral Society.

Tooele.—A 6-percent decline in minerals production value from 1962 resulted from decreased production of minerals of the nonmetals group, which accounted for 82 percent of the total. Quicklime and hydrated lime for use in chemical, construction, and other industries was produced by The Flintkote Co. at its limestone processing plant near Grantsville; quicklime (dead-burned dolomite) for use in refractories was produced by Utah Marblehead Lime Co.

Standard Magnesium & Chemical Corp., purchaser of the assets of Bonneville, Ltd., continued to produce potassium salts from its evaporation plant at Wendover. Leslie Salt Co. near Tooele, Solar Salt Co. near Grantsville, and Utah Salt Co. near Wendover produced 170,237 tons of solar-evaporated salt from Great Salt Lake brine, valued at $1.5 million, compared with 166,177 tons, valued at $1.6 million, in 1962.

Output value of stone was 7 percent less than in 1962. Crushed limestone was produced by The Flintkote Co. for use in manufacturing cement and lime, as rock dust for coal mines, as flux, and as asphalt filler; by Utah Marblehead Lime Co. for manufacturing dead-burned dolomite; and by Utah Calcium Co., Inc., for use as poultry grit and stone sand and in cast stone, roofing, and terrazzo. Utah Calcium Co., Inc., also produced dimension limestone for use as building stone. Marble and standstone were crushed by Aggregate Supply, Inc., for use in precasting. A 29-percent drop in output of sand and gravel was caused by a decrease in building and road construction. Miscellaneous clay, used in manufacturing building bricks, was produced by Interstate Brick Co., at the Five Mile Pass pit. Agate, green quartz, and quartz crystals, valued at $463, were collected by Dugway Gem & Mineral Society, Stan's Shop, and Wasatch Gem Society.

Output of silver, lead, and zinc increased; that of gold remained the same; and copper production decreased. According to the USSR&M Co. annual report, production at the silver-lead-zinc property (Ophir mine, operated by McFarland & Hullinger, lessees) was slightly higher both in tonnage and grade than in 1962; an expanded exploration and development program was begun during the year.

Small amounts of silver, lead, and zinc were produced by George Justice at the Black Hawk mine; gold, silver, lead, and zinc were produced by John D. Reed, lessee, at the Combined Metals Reduction Co. Calumet mine.

Uintah.—Petroleum, gilsonite, natural gas, LP gases, and natural gasoline, in order of value, accounted for 95 percent of the county mineral value. Petroleum production from 254 oil wells in 1 undesignated and 7 established fields was 18 percent higher than in 1962. California Oil Co., Western Division, having a production of 3.9 million barrels of crude petroleum from 162 wells in the Red Wash field, was the leading producer. Output of natural gas from 62 gas wells in 3 undesignated and 8 established fields represented only 23 percent of the total gas production; the major gas production came from oil wells located in the Red Wash field. California Oil Co. produced natural gasoline and LP gases (butane and propane) at its Jensen natural gas processing plant from oil-well gas recovered in the Red Wash field.

The only production of gilsonite in the United States came from Uintah County. Gilsonite producers, in order of importance, were American Gilsonite Co., Ziegler Chemical & Mineral Corp., United States Gilsonite, and Standard Gilsonite Co.

Output value of phosphate rock was 21 percent less than that for 1962. The material, mined at the Vernal unit of the San Francisco Chemical Co., was processed by Western Phosphates, Inc., at Garfield for agricultural and industrial uses. Sand and gravel was produced for building and road construction.

Utah.—The county was ranked third in the State in output value of sand and gravel, representing 44 percent of its mineral production value, as well as a decline from $1.4 million in 1962 to $1.1 million, owing to road construction completions. The output came from 23 operations—12 commercial and 11 Government-and-contractor. Principal commercial producers, in order of production, were Thorn Construction Co., Inc., Thorn Rock Products Co., and Strong Co.

Stone production value was 12 percent more than that for 1962. Crushed limestone was quarried by United States Steel Corp. at the Keigley quarry for use as flux, in refractories, as concrete aggregate and roadstone, and as railroad ballast; by Lakeside Lime & Stone Co. for use as coal mine dust and in manufacturing lime. Aggregate Supply, Inc., produced crushed marble at the Creme Travertine quarry for use in precasting.

Value of clay production was 50 percent greater than in 1962. Fire clay was produced at the Clinton Clay and Five Mile Pass pits and miscellaneous clay at the Elberta pit by International Pipe and Ceramics Corp. for manufacturing building brick and vetrified sewer pipe; fire clay was produced by R. D. Wadley Clay Co. at the Wadley pit for use in foundries and steelworks and by Cedarstrom Fire Clay Co. at the Fawn pit for use in mortar; and miscellaneous clay was produced by Interstate Brick Co. at the Powell pit and by Loyd Stubbs at the Northeast pit for use in making building bricks.

High-calcium quicklime and hydrated lime produced by Lakeside Lime & Stone Co. was less than in 1962. The lime was used for agricultural, chemical, and industrial purposes.

According to the Kennecott Copper Corp. 1963 annual report, progress was made in sinking a production shaft, construction of surface facilities, and underground development necessary for mining the orebody at Tintic Division mine (Burgin Shaft area). Production of limited tonnages of ore from horizons above the water table was made. Besides this output of gold, silver, copper, lead, and zinc, Tintic Standard Mining Co. produced silver, copper, lead, and zinc at Iron Blossom mine; and Walter R. Mories mined silver, lead, and zinc at Silver Dipper mine, American Fork District. Bird's eye marble and honey onyx, valued at $188, were collected by Dugway Gem & Mineral Society and F. D. Halladay.

Wasatch.—Metals contributed 98 percent of the $3.7 million mineral-output value. A fivefold increase from 1962 resulted from full-time production by Hecla Mining Co. at the Mayflower mine during 1963, compared with approximately 4 months of production in 1962. United Park City Mines Co. produced a little less ore at the United Park City mine than in 1962.

The annual report of the United Park City Mines Co. stated that the depressed condition, prevailing in Park City for more than 10 years, was greatly alleviated by a recreational and land development program conducted by the company in the area. Of $2 million spent or committed for expenditure, $1.2 million was loaned to the company by the Area Redevelopment Administration. A 13,000-foot gondola lift, a mountain restaurant, a nine-hole golf course, and a complex of skilifts were constructed.

Output value of stone was 82 percent less than that of 1962 as a result of a drop in production of granite riprap by contractors of the Federal Bureau of Reclamation, caused by the near completion of the Willard Dam. In addition to 14,704 tons of granite riprap and 25 tons of crushed sandstone produced in 1963 by contractors of the Federal Bureau of Reclamation, Eugene Tuckett Flagstone Co. produced 443 tons of dimension sandstone at the Crooks quarry for use in rough construction; Wilford Hansen Stone Quarries, Inc., produced 400 tons of dimension sandstone at the Wasatch quarry for use as building stone.

Value of sand and gravel production, used entirely by the Utah State Department of Highways for paving, was 71 percent less than that of 1962 because of less road construction.

Washington.—An increase of 94 percent in mineral-output value was due chiefly to a more complete statistical coverage in production of sand and gravel (major mineral commodity of the county) for road construction. Silver ore (containing copper, lead, and zinc) was mined by Intermountain Exploration Co. at Silver Reef mine, Bull Valley district. Selenite was collected by the Fawcett Hobby Shop.

Wayne.—A small quantity of sand and gravel was produced for paving. Jasper and opalite were collected.

Weber.—International Pipe and Ceramics Corp. produced miscellaneous clay from the Harrisville, Pleasant View, and West Ogden pits for use in manufacturing building bricks. Sand and gravel, used for building and road construction, reflected increases of 69 percent in tonnage and 63 percent in value over that of 1962.

The Mineral Industry of Vermont

By James R. Kerr [1]

DESPITE increases in roadbuilding activity which brought about near-record highs in the production of aggregate material, the value of Vermont's mineral industry declined slightly in 1963. Decreased production of dimension marble and lower prices for dimension granite production were the leading factors in the decreased valuation. Decreases in production and selling prices of asbestos also contributed to the decline.

Rutland County with its valuable marble and slate output led in value of mineral production. Washington and Orleans Counties followed Rutland with granite and asbestos as their leading commodities, respectively.

TABLE 1.—Mineral production in Vermont [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	(2)	$2	(2)	(3)
Sand and gravel short tons	1,430,466	1,076	2,374,575	$1,410
Stone do	1,714,676	19,815	2,158,603	19,193
Value of items that cannot be disclosed: Asbestos, clays, lime, talc, and values indicated by footnote 2		4,237		3,788
Total		25,130		24,391

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Figure withheld to avoid disclosing individual company confidential data.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

[1] Mining engineer, Bureau of Mines. Pittsburgh, Pa.

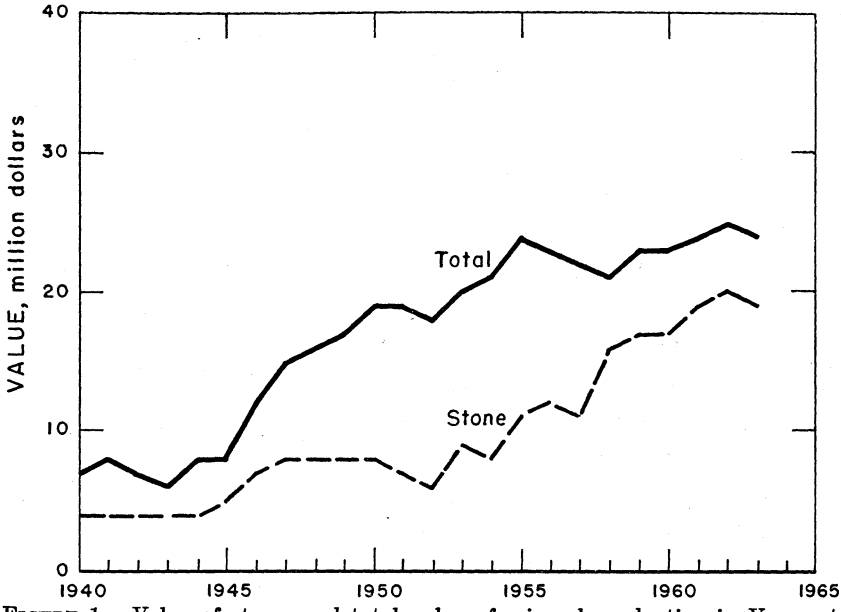


FIGURE 1.—Value of stone, and total value of mineral production in Vermont, 1940–63.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	20,350	1958	21,583
1953	21,945	1959	22,886
1954	21,705	1960	22,656
1955	24,346	1961	24,096
1956	22,069	1962	24,893
1957	22,065	1963	24,177

Water.—Recognizing the growing importance of an adequate supply of water to the Nation's mineral industries, the Bureau of Mines canvassed the mineral industries in 1963 to obtain water use data in 1962. The greatest volume user of water in the State was the dimension stone industry because a considerable amount of water is required in cutting, grinding, and polishing. The sand and gravel industry also used large quantities of water in washing and screening operations.

TABLE 3.—Water use by the mineral industry in 1962

(Million gallons)

Type of operation	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	377	146	523	340	37	19.05
Nonmetal mines and mills	56	2	58	45	11	13.27
Sand and gravel plants	149	----	149	140	9	138.61
Total	582	148	730	525	57	23.21

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—Downward adjustments in the selling prices of most grades and fewer operating days, led to decreased output of chrysotile asbestos. Twenty-six grades were sold compared with only 18 in 1962. Average prices varied from $30 to $376 per ton, depending upon length and quality of fiber.

Clays.—Kaolin, used principally for manufacturing floor and wall tile, was produced by one company in Addison County. Production was increased over that of 1962. Miscellaneous clay for building brick was produced at one operation in Chittenden County. The clay operation of Rutland Fire Clay Co. in Rutland County was discontinued in 1962.

Gem Stones.—Miscellaneous gem minerals, including talc, garnet, graphite, magnetite, jasper, and pyrite were collected by hobbyists at scattered locations throughout the State.

Lime.—Combined production of quicklime and hydrated lime decreased slightly. Quicklime was consumed largely by the paper industry and hydrated lime was used by the construction and chemical industries.

Mica, Reconstituted.—Specially delaminated mica scrap was processed to manufacture reconstituted mica at Rutland.

Sand and Gravel.—Renewed roadbuilding activity spurred the sand and gravel industry to a 66-percent increase in production over 1962. Both commercial and Government-and-contractor output was greatly accelerated. Average value per ton of commercial sand and gravel production dropped $0.14 to $0.86 in 1963. Total commercial production was almost evenly divided between sand and gravel. However, the average price per ton for gravel was $1.07 compared with only $0.66 for sand. Paving was the largest market for both.

Government-and-contractor production, particularly in Chittenden, Windham, and Addison Counties, increased significantly over that of 1962. The Vermont State Highway Department produced most of the Government-and-contractor tonnage. This production is not discussed in the county review section but is listed in table 4.

TABLE 4.—Sand and gravel production by Government-and-contractor operations, by counties

(Short tons)

County	1962	1963	County	1962	1963
Addison	10,132	152,707	Orleans	49,255	51,785
Bennington	78,288	122,099	Rutland	36,138	29,453
Caledonia	20,147	4,000	Washington	73,319	68,736
Chittenden	70,946	386,358	Windham	9,036	311,398
Essex	26,107	77,799	Windsor	99,545	51,980
Franklin	204,104	8,550	Unspecified	44,354	----------
Grand Isle	16,458	----------	Total	753,346	1,283,438
Lamoille	9,500	5,771			
Orange	6,017	12,802			

Stone.—Stone production in 1963 increased 26 percent, but the total value dropped slightly. Aggregate production regained some of the markets lost in 1962, but the production of dimension marble was curtailed and the average price for dimension granite was lowered, resulting in lower overall stone value. The dimension slate industry continued its vigorous recovery, increasing 12 percent over 1962. Greatly expanded production of crushed granite by Government-and-contractor operators offset the loss in output of crushed sandstone for concrete aggregate and roadstone. Crushed limestone production for aggregate use increased. In terms of tonnage, Chittenden County was the leading producing county, but Rutland and Washington Counties with their more valuable dimension stone production, led in value of stone output.

Talc.—Output of talc remained at virtually the same rate as in 1962. Production from three mines was ground at two mills prior to shipment. Demand for talc by the roofing industry, the major consumer, remained firm. The rubber and paper markets also consumed significant quantities.

REVIEW BY COUNTIES

Addison.—Increased production of sand and gravel was reported. Champlain Construction Co. produced chiefly building and paving sand and gravel at a portable plant near Middlebury and Roy Shackett produced bank-run gravel near Liecester. Kaolin was mined by Vermont Kaolin Corp. at an open pit near Bristol. Production, which was used chiefly for manufacturing floor and wall tile, more than doubled that of 1962. Vermont Associated Lime Industry, Inc., hydrated lime at New Haven from quicklime produced at its Winooski calcining plant in Chittenden County.

Bennington.—William E. Dailey, Inc., and Burgess Brothers, both with plants near Bennington, produced mostly paving and building sand and gravel. G. & H. Sand and Gravel Co., Inc., a new producer, sold bank-run gravel for building, and sand for fill and building uses. The Vermont Highway Department quarried sandstone for roadstone.

TABLE 5.—Value of mineral production in Vermont, by counties

County	1962	1963	Minerals produced in 1963, in order of value
Addison	(1)	(1)	Sand and gravel, clays, lime.
Bennington	$180,445	$164,381	Sand and gravel, stone.
Caledonia	(1)	(1)	Do.
Chittenden	1,150,468	1,627,877	Stone, sand and gravel, lime, clays.
Essex	(1)	27,229	Sand and gravel.
Franklin	(1)	(1)	Stone, sand and gravel.
Grand Isle	(1)	(1)	Stone.
Lamoille	(1)	(1)	Talc, sand and gravel.
Orange	(1)	(1)	Stone, sand and gravel.
Orleans	(1)	(1)	Asbestos, stone, sand and gravel.
Rutland	11,774,578	10,708,552	Stone, sand and gravel.
Washington	(1)	(1)	Do.
Windham	218,581	707,058	Stone, sand and gravel, talc.
Windsor	534,880	558,188	Stone, talc, sand and gravel.
Undistributed	11,271,150	10,597,728	
Total	25,130,000	24,391,000	

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Caledonia.—Paving sand and gravel was produced by Lawrence Sangravco, Inc., and Caledonia Sand & Gravel Co., Inc., at portable plants near St. Johnsbury. Output was slightly less than in 1962. The latter company also produced crushed ledge stone (miscellaneous) for concrete aggregate and roadstone.

Chittenden.—Production of crushed limestone was the leading mineral industry with L. A. Demers Crushed Rock Co. producing roadstone and concrete aggregate, and Vermont Associated Lime Industry, Inc., producing agricultural stone (agstone). The latter company also produced lime, largely for use by the paper industry. The State Highway Department also produced crushed limestone for use in highway construction.

W. C. Kirby, contractor, produced sand and gravel near Burlington principally for fill and paving. Campbell Construction, Inc., produced paving gravel from leased pits and building and fill sand from its own pit near Williston. George C. Stanley & Sons, Inc., produced bank-run fill sand near Burlington and Hinesburg Sand and Gravel Co. produced processed paving sand and gravel at Hinesburg. Vermont Paving Corp. discontinued its sand and gravel business.

Densmore Brick Co. mined miscellaneous clay for building brick at an open-pit mine near Essex Junction.

Essex.—The sand and gravel operation of A. Booska Sand & Gravel Co. Inc., was idle in 1963.

Franklin.—Swanton Lime Works, Inc., quarried limestone near Swanton and sold crushed limestone for roadstone, agstone, and to paper mills and mineral food dealers.

S. H. Evanson produced mostly building and paving sand at a stationary plant near Swanton. Ray Dubois produced bank-run paving and fill sand also near Swanton.

Grand Isle.—Vermont Marble Co. produced dimension and crushed marble at its Isle La Motte quarry.

Lamoille.—Eastern Magnesia Talc Co., Inc., mined talc at its No. 4 mine near Johnson. Output was ground and sold chiefly to the roofing, rubber, and paper industries. Smaller quantities were sold for paint and insecticide manufacture.

Albert Nadeau produced processed paving sand and gravel at a portable plant near Johnson. Kenneth Farr produced bank-run sand and gravel chiefly for paving near Morrisville.

Orange.—The Rock of Ages Corp., Pirie Division, quarried dimension granite near Williamstown for use chiefly as rough monumental stone. A small tonnage of rubble also was produced.

Willard B. Martin produced paving gravel near Bethel, and Levi Lemieux produced bank-run sand and gravel for a variety of uses.

Orleans.—Vermont Asbestos Mines, Division of the Ruberoid Co. mined chrysotile asbestos at the Lowell mine for processing at the company's mill in Lamoille County. Shipments of asbestos were slightly less than in 1962. The company also recovered a small quantity of roadstone from waste rock at the Lowell mine.

The Vermont Highway Department produced crushed sandstone for roadstone and Irio Bianchi quarried a small tonnage of dimension granite for rough construction. Howard G. Calkins produced paving sand and gravel at a stationary plant near Danville.

Rutland.—Production of dimension marble slackened from the high rate of 1962 but the industry maintained its top ranking among the State's mineral industries. Vermont Marble Co. operated five quarries and five finishing plants (reactivating its Blue quarry in 1963) and produced largely cut exterior and interior dressed building stone. Significant quantities of sawed, dressed building stone also were produced. Green Mountain Marble Division of Georgia Marble Co. operated a quarry and finishing plant near West Rutland and sold chiefly cut, dressed monumental stone. The market for dimension slate remained firm and significant quantities were sold for flagging, structural and sanitary uses, and for roofing. Of the 22 active quarries, the larger were operated by Vermont Structural Slate Co., Inc. (5 quarries); Hilltop Slate Co.; Tatko Bros. Slate Co.; Fairhaven Slate Co., and Rising and Nelson Slate Co., Inc. (3 quarries). Limestone for whiting was quarried by White Pigment Corp. at South Wallingford. Vermarco Lime Co. operated the Loveland quarry near Florence and produced crushed limestone chiefly for roadstone and agstone.

J. P. Carrara & Sons, Inc., produced processed sand and gravel for building and paving and for ice control at a stationary plant near Rutland. The clay operation of Rutland Fire Clay Co. was discontinued. Vermont Light Aggregate Corp. was constructing a plant near Castleton to process waste slate fines into lightweight aggregate. The facility is scheduled to become operational in mid-1964. Large quantities of slate fines are available at the plant site, the location of an abandoned roofing granule plant.

Washington.—Dimension granite, mainly in the form of rough monumental stone, was produced by Rock of Ages Corp. (three quarries) and Wells-Lamson Quarry Co., Inc. Production was greater than in 1962, but total value was less because of lower prices. Woodbury Quarries, Inc., quarried granite in association with the John Swenson Granite Co. for processing in both companies' mills. Garand-Teed Quarries, Inc., took over the operation of S. L. Garand Co., Inc., and produced mostly rough monumental granite.

Sand and gravel, mainly for paving, was produced by Caledonia Sand & Gravel Co., Inc., at Plainfield; A. King's Pit at South Barre; and Le Page's Gravel Pit at Barre.

Windham.—Greatly increased production of crushed granite for roadstone and concrete aggregate was reported by the Vermont Highway Department which indicates that there was increased road-building in the area. Brattleboro Sand & Gravel Co., Inc., produced building and paving sand and gravel at a stationary plant near Brattleboro.

Vermont Talc Co. mined talc near Windham and shipped the crude material to its grinding mill at Chester in Windsor County. The ground material was mostly sold to the rubber, plastics, insecticide, and paper industries.

Windsor.—Vermont Marble Co. produced crushed and dimension marble at its Rochester quarry. The Rock of Ages Corp. produced mainly rough architectural building granite plus some rubble at the Bethel quarry. No crushed granite was sold in 1963.

The Eastern Magnesia Talc Co., Inc., mined crude talc at its Hammondsville No. 3 mine near Reading and shipped the crude material to Chester for grinding at its mill. Output was sold for a variety of uses, chief among which were roofing and rubber. Sand and gravel for building and paving was produced by Sharon Sand & Gravel, Inc., Sharon and Martin Marietta Co., Concrete Products Div., Windsor. A. Booska Sand and Gravel Co., Inc., produced paving sand and gravel at a portable plant.

747-416—64——71

The Mineral Industry of Virginia

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Virginia Division of Mineral Resources for collecting information on all minerals except fuels.

By Robert W. Metcalf [1] and James L. Calver [2]

THE value of Virginia's mineral production in 1963 totaled $229 million, 3 percent greater than in 1962 and only 1 percent less than in 1957, the record year. Production and value of stone, sand and gravel, and kyanite rose to new highs. Records also were established in tonnage of coal mined and in value of clay produced. Accelerated highway and other construction was a prime influence in increases in quantity of stone, sand and gravel, gypsum, and masonry cement produced. Output of clays and portland cement were only slightly under those of 1962. Fuels comprised 53 percent of the total value of mineral production in the State, the same as in 1962. The value of nonmetals rose to 44 percent of the total value, while the value of metals declined to 3 percent.

TABLE 1.—Mineral production in Virginia [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Aplite thousand long tons	125	$912	(2)	(2)
Clays thousand short tons	1,464	1,444	1,410	$1,558
Coal (bituminous) do	29,474	117,560	30,531	120,972
Gem stones	(3)	6	(3)	6
Lead (recoverable content of ores, etc.) short tons	4,059	747	3,500	756
Lime thousand short tons	615	7,668	639	8,058
Natural gas million cubic feet	2,499	677	2,085	488
Petroleum (crude) thousand 42-gallon barrels	3	(2)	3	(2)
Sand and gravel thousand short tons	9,745	16,375	10,400	17,752
Soapstone short tons	(2)	(2)	3,696	9
Stone thousand short tons	25,766	43,121	27,653	45,529
Zinc (recoverable content of ores, etc.) [4] short tons	26,479	6,141	23,988	5,725
Value of items than cannot be disclosed: Portland cement, masonry cement, feldspar, gypsum, iron ore (pigment material), petroleum (crude), kyanite pyrites (1962), salt, titanium concentrate (ilmenite and rutile), and values indicated by footnote 2	----------	27,843	----------	28,212
Total	----------	222,494	----------	229,065

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Weight not recorded.
[4] Recoverable zinc valued at the yearly average price of prime western slab zinc, East St Louis market. Value established after transportation, smelting, and manufacturing charges have been added to the value of ore at the mine.

[1] Mineral specialist, Bureau of Mines, Pittsburgh, Pa.
[2] State geologist, Virginia Division of Mineral Resources, Charlottesville, Va.

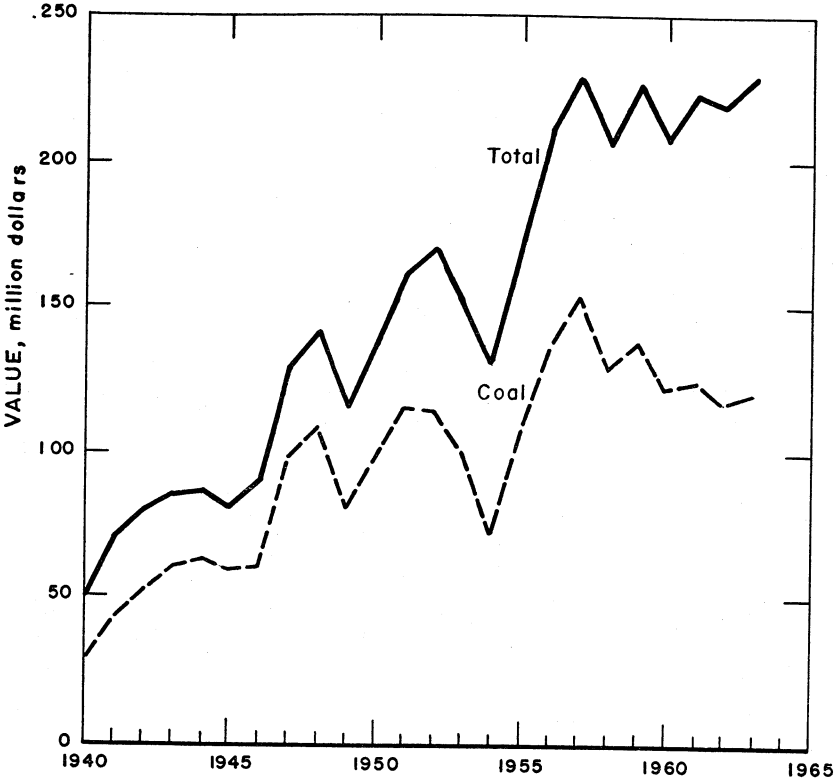


FIGURE 1.—Value of coal, and total value of mineral production in Virginia, 1940–63.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

As an aid to the commercial and industrial development of the mineral industries in Virginia, the Virginia Division of Mineral Resources issued a revised 1963 edition of both geologic and mineral

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$168,601	1958	$205,257
1953	154,516	1959	230,552
1954	137,760	1960	214,308
1955	174,562	1961	234,464
1956	209,566	1962	233,985
1957	222,906	1963	240,744

resources maps. More than 250 new mineral localities were listed in a recently published bulletin, one of a series reporting known mineral localities in Virginia. A number of minerals or varieties not heretofore reported in this series also were included.[3] The geology and mineral resources of the Saltville area were described. A brief history of the mining of salt, gypsum, and limestone was included. The salt and gypsum deposits are the only sizable ones in Southeastern United States.

Studies of the geology and mineral resources of Virginia included reports on Greene and Madison Counties,[4] the Clinchport Quadrangle (Scott County),[5] the Triassic Formations of the Danville Basin [6] and part of Lee County.[7] The last publication contained estimates of original coal reserves and remaining recoverable reserves for five principal coal beds in a 60-square-mile quadrangle in Bell and Harlan Counties, Kentucky, and Lee County, Virginia. Of interest also were magnetic surveys of the Coastal Plain [8] and the Contrary Creek quadrangle in Louisa and Spotsylvania Counties.[9]

Employment and Injuries.—Coal mine fatalities included 22 underground fatalities and 3 surface or strip mining deaths. Of the underground fatalities, 18 were due to falls of roof, rib, face, etc., and 4 to haulage, electricity, and machinery accidents. Twelve Virginia quarries were awarded outstanding safety records by working from about 32,000 to nearly 95,000 man-hours without lost-time accidents. One mine in the nonmetals group received an outstanding safety award by achieving about 70,000 man-hours of exposure without a lost-time injury.

Trends and Developments.—Norfolk & Western Railway's Lambert's Point pier 6 coal loading facilities added a second 17-story, 180-foot high tower, completed in July (the first tower was placed in operation in December 1962). Electronic control of custom-blended coals, twin 8-foot-wide conveyor belts, self-propelled loading towers, and 120-foot retractable loading booms allow a rated capacity of 16,000 tons per hour and a maximum capacity of 20,000 tons per hour. Four ships may be loaded at the same time along the 1,600-foot pier.[10] In the continuing effort to transport coal economically and particularly to supply the coming unit train movement of bulk commodities, the Norfolk & Western Railway also is testing an experimental 150-ton capacity coal hopper car in trial runs from tipples to consumers.

An effort to reconcile production and preservation of raw material resources and the normal growth of residential, commercial, and in-

[3] Dietrich, R. V. Virginia Mineral Localities (Supplement II). Va. Polytech Inst. Eng. Exp. Sta. Ser. 151, Blacksburg, Va., March 1963, 39 pp.

[4] Allen, Rhesa M., Jr. Geology and Mineral Resources of Greene and Madison Counties. Virginia Division of Mineral Resources, Bull. 78, Charlottesville, Va., 1963, 102 pp.

[5] Brent, William B. Geology of the Clinchport Quadrangle, Virginia. Virginia Division of Mineral Resources, Rept. of Inv. 5, Charlottesville, Va., 1963, 47 pp.

[6] Meyertons, Carl T. Triassic Formations of the Danville Basin. Virginia Division of Mineral Resources Rept. of Inv. 6, Charlottesville, Va., 1963, 65 pp.

[7] Englund, K. J., H. L. Smith, L. D. Harris, and J. J. Stephens. Geology of the Ewing Quadrangle, Kentucky, and Virginia. U.S. Geol. Survey Bull. 1142–B (Contributions to Economic Geology), 1963, pp. B1–B23.

[8] LeVan, D. C., and R. F. Pharr. A Magnetic Survey of the Coastal Plain in Virginia. Virginia Division of Mineral Resources Rept. of Inv. 4, Charlottesville, Va., 1963, 17 pp.

[9] Bromery, R. W., G. A. Galat, and F. P. Gilbert. Aeromagnetic Map of Contrary Creek Quadrangle, Louisa and Spotsylvania Counties, Va. U.S. Geol. Survey GP–389, 1963. (Scale, 1:24,000 (1 inch=2,000 feet). Contour interval, 50 gammas.)

[10] Engineering News Record. New Pier Can Load Coal at 20,000 tons per hour. V. 171, No. 16, Oct. 17, 1963, p. 26. The Commonwealth. N&W Dedicated $25 million Coal Pier. V. 30, No. 10, October 1963, pp. 42, 45.

TABLE 3.—Employment and injuries for selected mineral industries

Industry	Average number of men working	Total man-hours	Total number of lost-time injuries		Number of injuries per million man-hours	
			Fatal	Nonfatal	Fatal	Nonfatal
1962:						
Coal mines	(1)	(1)	22	(1)	(1)	(1)
Metals [2]	385	778,559	1	28	1.28	35.96
Clay mines [3]	63	104,345		3		28.75
Nonmetal mines [4]	198	422,804		5		11.83
Quarries and mills [5]	3,551	7,657,234	3	134	.39	17.50
Sand and gravel [6]	749	1,601,224		48		29.98
1963: [7]						
Coal mines	(1)	(1)	25	(1)	(1)	(1)
Metals [2]	378	738,447		31		41.98
Clay mines [3]	47	85,618				
Nonmetal mines [4]	150	331,607				
Quarries and mills [5]	3,757	8,152,207	4	140	.49	17.17
Sand and gravel [6]	957	2,102,885		30		14.27

[1] Data not available.
[2] Includes mine and mill data; excludes officeworkers.
[3] Excludes mill data and officeworkers.
[4] Excludes clay mines, also nonmetal millworkers and officeworkers.
[5] Includes cement and lime plants having no quarry operations; excludes officeworkers.
[6] Excludes officeworkers.
[7] Preliminary figures.

dustrial facilities, particularly in and around large centers of population, led to the preparation of a Natural Resources Development plan by the sand and gravel producers of Fairfax County, with substantial aid from the National Sand & Gravel Association. This plan would provide for the mining of valuable reserves of sand and gravel prior to residential, commercial, or industrial development, followed by carefully planned restoration of worked-out areas. Although designed at the start as a master plan for the many regions facing aggregate depletion, it was discovered that because of special needs or conflicts, each area must chart its own course.

Indicating the increasing importance of Virginia in nuclear activity and programs were the $705,000 National Science Foundation grants to the University of Virginia for a 6-million-volt Van de Graaff nuclear accelerator and a new nuclear physics laboratory. The accelerator, costing $526,000, will be the only such equipment in the world other than a similar accelerator at Los Alamos Scientific Laboratory in New Mexico. The new laboratory, to cost $358,000 (including a National Science Foundation grant of $179,000), will house not only the 6-million-volt nuclear accelerator, but also a 75-million-volt synchrotron given to the university several years previously by General Electric Co. The Van de Graaff accelerator accelerates protrons and heavier nuclear particles while the synchrotron accelerates electrons.[11]

Legislation and Government Programs.—Because of the discontinuance of the Federal mica purchasing program, neither commercial sales nor Government purchases of sheet mica were reported in 1963.

Water.—The need for background statistics to implement programs for water conservation and to provide guidelines for proper and efficient utilization of water resources for commercial, industrial, and

[11] The Commonwealth of Virginia. University of Virginia Gets Funds for Nuclear Accelerator and Lab. V. 30, No. 4, April 1963, pp. 8, 10.

recreational use and consumption led to a survey for the year 1962 of the actual quantities of water used in the mineral industries.

Only a little more than 1 percent of the total water was used in mining, nearly 98 percent in processing operations, and the remainder chiefly as cooling and condensing water, including that used for electric power generation, boiler feed, sanitary, and miscellaneous uses.

Of the new water used, 12 percent was consumed, and the balance discharged, chiefly as surface water to streams or lakes (73 percent) and as ground water into the earth (26 percent). Minor quantities were discharged into sewers or transferred to others.

Only 7 percent of the new water used by the mineral industries was treated before use, virtually all of the recycled water was treated, and over 60 percent of the discharged water was treated before release. Of the new water treated, over three-quarters was settled, and most of the remainder was treated by filtration or with bactericides. About 95 percent of the recirculated water was settled and the balance filtered or precipitated. Nearly 75 percnt of the discharged water was settled before release, about 11 percent each precipitated and treated for pH content, and the balance filtered.

TABLE 4.—Water use in the mineral industry in 1962

(Million gallons)

Types of operation	New water	Water recirculated	Total water use	Water discharged	Water consumed	Gallons of new water per dollar value of production
Coal mines	1,594	8,010	9,603	1,316	278	29.37
Metal mines and mills	934	239	1,173	817	117	116.21
Quarries and mills	1,185	539	1,724	1,073	112	27.73
Sand and gravel mines	2,797	1,472	4,269	2,655	142	170.79
Other nonmetal mines and mills	458	882	1,341	282	176	56.26
Petroleum and natural gas	1	----	1	1	----	----
Total	6,969	11,142	18,111	6,144	825	----

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Output of 30.5 million tons of bituminous coal in 1963 was a new record, 1 percent higher than in the former record year of 1961, and 4 percent greater than in 1962. The value of the output increased 3 percent over that of 1962 and was only 4 percent below the record high value of 1961. The average value per ton continued to decline and was $3.96 compared with $3.99 in 1962 and $4.16 in 1961. Virginia produced high- and low-volatile coals for domestic and industrial heating and industrial power as well as a small amount of semianthracite for domestic heating. Large quantities of both high- and low-volatile coals were exported. Underground production totaled 88 percent of the State's total, strip mine output 7 percent, and auger mine production 5 percent. New preparation equipment at 13 large Virginia mines was rated at over 2,250 tons

per hour, of which nearly two-thirds (1,400 tons per hour) were installed by 3 companies, Beatrice Pocahontas Co., Keen Mountain; Coal Processing Corp., Norton; and Little River Coal Co., Inc., Grundy.[12]

TABLE 5.—Coal (bituminous) production and value, by counties

(Thousand short tons and thousand dollars)

County	1962		1963	
	Quantity	Value [1]	Quantity	Value [1]
Buchanan	11,997	$45,179	13,141	$50,435
Dickenson	8,356	35,119	8,257	32,741
Lee	453	1,666	502	2,065
Montgomery	11	43	13	45
Russell	2,024	9,461	1,904	8,807
Scott	12	61	3	11
Tazewell	460	1,500	469	1,530
Wise	6,161	24,531	6,242	25,338
Total	29,474	117,560	30,531	120,972

[1] Value received or charged for coal f.o.b. mine, including selling cost. (Includes value for coal not sold but used by producers, such as mine fuel, and coal coked as estimated by producer at average prices that might have been received if such coal had been sold commercially.)

The number of mines in Virginia increased to 1,485, a 10-percent increase over the number in 1962. Underground and auger mines rose to 1,396 and 51, respectively, while the number of strip mines declined to 38 compared with 44 in 1962. Mechanically loaded coal totaled 44 percent of the total underground output, of which 80 percent was loaded by 121 mobile loading machines. Twenty-three continuous mining machines also were used. Of the total coal mined, 42 percent was mechanically cleaned in 27 cleaning plants. Wet washing other than jigs accounted for 71 percent of the cleaned coal. Coal crushed totaled 38 percent of the total coal mined. About 11 percent of the total coal produced was treated with dust-laying and antifreezing preparations, of which oil had by far the greatest share (96 percent).

Coke.—Coke was produced by six companies in 1963, five in Wise County and one in Buchanan County. There were 877 beehive ovens in operation, of which 390 were rectangular or horizontal-bed internal combustion ovens. Machine-drawn ovens totaled 756, and hand-drawn ovens 121. No slot ovens were operated and no byproducts recovered. Output increased substantially compared with that of 1962.

Fuel Briquets and Packaged Fuel.—Packaged fuel prepared from bituminous coal was produced by Wright Coal & Oil Co., Inc., Norfolk. Fuel briquets were not made in Virginia.

Petroleum and Natural Gas.—Production of natural gas during 1963 totaled 2,084,946 thousand cubic feet, a decrease of 17 percent from the production of 1962. Buchanan County reported production of 1,479,776 thousand cubic feet which was delivered to the pipelines of Hope Natural Gas Co. and United Fuel Gas Co. Dickenson County produced 605,170 thousand cubic feet which was placed in the

[12] Coal Age. New Bituminous Preparation Facilities. V. 68, No. 2, February 1963, pp. 78–79.

lines of the Kentucky-West Virginia Gas Co.[13] Of interest, was the development by drifting and room and pillar methods in granite of an underground storage area for LP gas in Fairfax County.

The American Gas Association estimated the reserve of natural gas to be 31,303,000 thousand cubic feet, a decline of 1,742,000 thousand cubic feet compared with that of 1962. Volume estimates, effective December 31, 1963, are at standard conditions of 14.73 pounds per square inch, absolute.

In Lee County, production of oil from the Rose Hill field was 3,466 barrels. One test well was plugged and abandoned. A small oil well was completed in the Trenton Limestone near Ben Hur, about 19 miles northeast of the Rose Hill field.

The American Oil Co. operated a skimming, cracking, and coking refinery at Goodwin Neck, York County, with a crude capacity of 38,000 barrels per calendar day, a cracking capacity of 36,500 barrels, and a reforming capacity of 6,800 barrels.

NONMETALS

Aplite.—Output of aplite for glass manufacture in 1963 decreased chiefly because two of the four companies producing in 1962 discontinued mining. One firm each in Hanover and Nelson Counties remained in operation.

Cement.—Shipments of portland cement declined only slightly in 1963 (2 percent). Shipments of masonry cement continued to increase and were 6 percent in quantity and 8 percent in value over those of 1962. Portland-cement-producing capacity remained virtually unchanged during the year. The dry process of manufacturing portland cement was used by two plants and the wet process by one. Both portland and masonry cements were made by three plants and one firm made masonry cement only. Production was confined to Augusta, Botetourt, and Warren Counties and the city of Chesapeake. The cement companies mined calcareous marl, limestone, and shale for their own use. Included among purchased materials used in the manufacturing process were sand, gypsum, oyster shells, mill scale, various air-entrained compounds, and certain grinding aids. General-use and moderate-heat cement (Types I–II) comprised 93 percent of the portland cement marketed. High-early-strength cement also was produced, and nearly half of the portland cement was air entrained. Most of the shipments were by railroad, but sizable quantities were shipped by truck and smaller tonnages by boat or barge. Most shipments were in bulk and the remainder in paper bags.

The distribution of portland cement by types of consumer was as follows: 60 percent to ready-mixed concrete companies (64 percent in 1962); 12 percent to contractors, including highway contractors (14 percent in 1962); 19 percent to concrete product manufacturers (13 percent in 1962); 8 percent to building material dealers (7 percent in 1962); and the remaining 1 percent to Federal, State, and local government agencies and miscellaneous customers. Virginia, North Carolina, Maryland, and West Virginia were the chief markets for

[13] Virginia Minerals. V. 10, No. 2, May 4, 1964.

portland cement. The bulk of the masonry cement was shipped to Virginia, North Carolina, the District of Columbia, and Maryland, and smaller shipments were made to Eastern, Midwestern, and Southern States. An $80,000 distribution facility in Richmond was to be erected by Lone Star Cement Corp.

Clays.—Production of clays declined slightly, although tonnage was higher than in 1961. Value, however, rose to nearly $1,560,000, a new record, about 8 percent above 1962, the previous high year in value. The only type of clay mined was miscellaneous or "common" clay and shale, over 60 percent of which was used in making building brick. Most of the remainder was consumed in the manufacture of lightweight aggregate and portland cement. Smaller tonnages were used in making vitrified sewer pipe, flue linings, and various other heavy clay products. Clay was produced by 15 companies at 21 operations in 16 counties. Three companies expanded clay or shale for lightweight aggregate, one each in Botetourt, Pittsylvania, and Russell Counties. The chief clay producing counties, in order of output, were Botetourt, Chesterfield, Russell, and Nansemond, and in order of value, Botetourt, Orange, Prince William, and Nansemond. A study of the raw materials used in making lightweight aggregates in Virginia, covering specifications, properties, and processing, was published. Included were descriptions of the operations of each company and illustrations of several of the plants.[14]

TABLE 6.—Clays sold or used by producers

Year	Short tons	Value	Year	Short tons	Value
1954–58 (average)	937,382	$951,753	1961	1,406,201	$1,332,165
1959	1,346,014	1,396,433	1962	1,464,417	1,443,927
1960	1,347,766	1,394,665	1963	1,410,098	1,558,327

Feldspar.—Feldspar was produced in Bedford County by one company. Combined output from three mines dropped over 28 percent compared with that of 1962. Potash and mixed spar were mined. Production and sale of ground feldspar from the company mill at Bedford also declined. The chief markets were for pottery and enamel manufacture. Smaller uses included welding rods and soaps and abrasives. Maryland, New Jersey, and Ohio were the chief consuming States.

Gem Stones.—Gem materials and mineral specimens gathered by collectors and hobbyists included amazonite and other materials in Amelia County; blue corundum in Carroll County; lepidolite in Dinwiddie County; olivine in Grayson County; and agate in Highland County.

Gypsum.—Crude gypsum was mined at Plasterco, Washington County, by United States Gypsum Co. The product was calcined and manufactured into plasterboard and other gypsum products at a nearby plant. Production rose moderately. A newly developed mine in Smyth County at Locust Cove was expected to be in operation in

[14] Smith, Carroll E. Lightweight Aggregate Industry in Virginia. Virginia Minerals, v. 9, No. 3, August 1963, pp. 1–6.

early 1964. The United States Gypsum Co. also calcined gypsum of both domestic and Nova Scotian origin at a company mill in Norfolk. Several firms in the Norfolk area ground Nova Scotian crude gypsum for use as a land dressing, especially for peanut growing.

Kyanite.—Kyanite Mining Corp. operated two mines, two flotation plants, and a pulverizing mill in Virginia. Sales of refined kyanite increased 11 percent. Recovery of crude kyanite also was greater than in 1962. Refractories and other ceramic manufacturers were the principal users of this material. Mines and flotation mills were in Buckingham and Prince Edward Counties and the pulverizing plant in Prince Edward County. Mining and milling procedures at the Baker Mountain, Willis Mountain, and Pamplin plants of this corporation were described in the trade press.[15]

Lime.—Increased demand for lime led to a rise of 4 percent in tonnage and 5 percent in value over that of 1962. Sales of agricultural lime were less than in 1962, while sales of building and chemical lime increased compared with those of 1962. There were nine companies which burned lime in seven counties. One company operating during 1962 was idle. The Kimballton plant (Giles County) of the Standard Lime & Cement Co., division of Martin-Marietta Corp., was sold to Foote Mineral Co., Exton, Pa., on October 31, and operated by the new owner for the remainder of the year. Oystershell was calcined by two firms near Norfolk for use as an agricultural land dressing. The chief lime-burning counties were Giles, Smyth, and Shenandoah. Natural gas, bituminous coal, and coke were used for firing lime in several types of equipment, including pot, shaft, and rotary kilns and batch and continuous hydrators.

Mica.—As in 1962, no sales of crude mica were reported. Wet ground mica was sold by Richmond Mica Corp., Newport News, to paint, plastics, rubber, and wallpaper manufacturers. Scrap mica from North Carolina and India was purchased for grinding at the company mill.

Nitrogen Compounds.—The Nitrogen Division, Allied Chemical Corp., Hopewell, Prince George County, manufactured nitrogen compounds for use in fertilizer. Ammonium sulfate, urea solution, ammonia, and other compounds were prepared for various industrial uses.

TABLE 7.—Lime sold or used by producers, by uses

Year	Agricultural		Building		Chemical and other industrial		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1954-58 (average)	(1)	(1)	(1)	(1)	(1)	$5,061,114	486,665	$5,429,446
1959	29,519	$351,955	5,345	$73,628	730,376	7,742,829	765,240	8,168,412
1960	27,011	319,829	5,541	82,753	678,487	7,625,404	711,039	8,027,986
1961	28,760	375,489	4,932	72,584	623,075	6,926,661	656,767	7,374,734
1962	31,104	426,476	2,816	40,629	580,593	7,201,198	614,513	7,668,303
1963	(1)	(1)	(1)	(1)	603,325	7,572,738	638,800	8,058,415

[1] Data withheld to avoid disclosing individual company confidential data; included in total.

[15] Mohler, Neal F. Moving a Mountain of Kyanite. Brick & Clay Record, v. 143, No. 4, August 1963, pp. 40–41.

Perlite.—Colorado perlite was expanded by a company at Hopewell, Prince George County, for use in concrete aggregate, soil conditioning, and building plaster. Total sales decreased compared with those of 1962, although the amount of perlite sold for concrete aggregate was higher than in previous years.

Salt.—Salt brine mined by a Saltville (Smyth County) corporation was consumed chiefly in the manufacture of soda ash, chlorine, and other chemicals. Production increased slightly compared with that of 1962.

Sand and Gravel.—Production of sand and gravel was 6 percent higher than in 1961, the former peak year, and the value was 8 percent above the previous record value in 1962. The average value of commercial sand and gravel rose 2 percent, from $1.69 to $1.72 per ton. The increase in production was due chiefly to active highway and building construction programs during the year. Paving and building uses combined accounted for 84 percent of the total commercial production (47 percent paving, 37 percent building). Included among other types of sand and gravel produced were glass sand, engine sand, filtration, fill, and miscellaneous sand, including sand for ice control. Building and paving sand and gravel output increased substantially over that of 1962, while the production of glass, molding, and engine sands was much less than in 1962. Commercial output totaled 98 percent of all production, of which 91 percent was washed, screened, or otherwise prepared. The balance, 2 percent, consisted of State, Federal, and local government output, of which 63 percent was processed material. Sand and gravel production was reported from 43 counties. Commercial output was divided almost equally between sand and gravel (49 percent sand, and 51 percent gravel).

There were 78 sand and gravel pits in 1963, operated by 73 firms. Nearly three-quarters of the commercial output was shipped by truck, and the balance by railroad and waterway. Waterway shipments were somewhat less than in 1962.

The principal counties producing sand and gravel were Fairfax, Henrico, Chesterfield, city of Virginia Beach (formerly Princess Anne County), and Prince George. Commercial sand and gravel produced in these five areas totaled 79 percent of the quantity and 82 percent of the total value of Virginia production. Measured by size of output, 41 of the commercial mines (52 percent of the pits) produced less than 25,000 tons each and accounted for only 20 percent of the total output. Twenty-four mines producing between 25,000 and 200,000 tons annually (31 percent of the pits) mined 19 percent, and 13 operations (17 percent of the producing mines), each producing more than 200,000 tons annually, accounted for 61 percent of the production of commercial sand and gravel.

Soapstone.—One company in Franklin County continued to market ground or crushed soapstone. Another firm operating in Nelson and Albemarle Counties, formerly crushing and grinding soapstone (Alberene Stone Division of Georgia Marble Co.), discontinued its grinding operations at Schuyler before the end of 1962. Sales declined slightly in 1963. Foundry facings and insecticides were the chief uses. Soapstone used as dimension stone is discussed in the "Stone" section of this chapter.

TABLE 8.—Sand and gravel sold or used by producers, by classes of operations and uses

Class of operation and use	1962		1963	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Building	1,546,599	$2,251,096	1,901,102	$2,841,615
Paving	1,945,967	2,476,029	2,128,500	2,927,665
Engine	50,392	108,503	(1)	(1)
Fill	618,840	247,978	435,464	231,455
Filtration	(1)	(1)	8,296	16,859
Other [2]	620,843	1,650,970	532,671	1,139,439
Total	4,782,641	6,734,576	5,006,033	7,157,033
Gravel:				
Building	1,542,175	3,149,873	1,890,998	4,012,714
Paving [3]	3,120,167	6,311,804	3,280,783	6,323,109
Fill	175,000	98,750	(1)	(1)
Total	4,837,342	9,560,427	5,171,781	10,335,823
Total sand and gravel	9,619,983	16,295,003	10,177,814	17,492,856
Government-and-contractor operations:				
Sand:				
Paving	52,645	5,937	32,727	11,736
Other	22,266	8,906	22,984	9,194
Total	74,911	14,843	55,711	20,930
Gravel:				
Paving	49,709	64,849	151,236	233,205
Fill			15,000	5,250
Total	49,709	64,849	166,236	238,455
Total sand and gravel	124,620	79,692	221,947	259,385
All operations:				
Sand	4,857,552	6,749,419	5,061,744	7,177,963
Gravel	4,887,051	9,625,276	5,338,017	10,574,278
Grand total	9,744,603	16,374,695	10,399,761	17,752,241

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes molding sand (1962), railroad ballast (1962), filtration sand (1962), engine sand (1963), glass sand, and ground sand.
[3] Includes fill (1963) and other gravel.

Stone.—Production of stone in Virginia in 1963 broke all records in both quantity and value for the sixth consecutive year and remained the second most important mineral commodity produced in Virginia, exceeded only by bituminous coal. Output in 1963 totaled 27.7 million tons valued at $45.5 million, an increase of 7 percent in quantity and 6 percent in value over that of 1962. Especially influencing the large rise in production of stone were substantial increases for granite, basalt, limestone, and sandstone, crushed and broken stone. Agricultural limestone (agstone) also had a large increase. Stone used as concrete aggregate and roadstone represented 71 percent of the total production, cement 7 percent, lime 5 percent, and metallurgical flux 4 percent. Of the metallurgical flux, 53 percent was consumed in open-hearth furnaces, and 43 percent in blast furnaces. Other sizable tonnages of limestone were consumed as stone sand, fertilizer and asphalt filler, and in ammonium nitrate and glass manufacture.

Many types of stone were quarried in Virginia, including limestone, granite, basalt, sandstone, marble, miscellaneous stone (soap-

stone, greenstone, and aplite), calcareous marl, and slate. Shell, a byproduct of the oyster and mollusk industries, also was used chiefly as an agricultural liming material, similar to agstone, and in the manufacture of lime. One firm in Buckingham County produced roofing granules from slate. The two firms in Nelson County formerly producing crushed and broken aplite discontinued the production of aplite for construction purposes. Limestone comprised 60 percent of the total stone, granite 24 percent, and basalt 11 percent. Crushed and broken stone accounted for by far the bulk of the total tonnage produced (99.8 percent). Dimension miscellaneous stone, dimension slate, and dimension sandstone accounted for the balance of the Virginia output.

Measured by tonnage the principal stone-producing counties were Frederick, Botetourt, Loudoun, Roanoke, and Washington. Measured by value of product, the most important counties were Frederick, Botetourt, Loudoun, Roanoke, and Fairfax. There were 8 counties with over 1 million tons of output, and 18 counties with production valued at over $1 million each. Commercial stone was obtained in 50 counties by 93 producers. Five State or municipal agencies in 10 counties produced Government-and-contractor stone. Two firms in two counties produced and marketed shell, and one other company purchased and processed shell for sale. The number of producers by types of commercial stone was as follows: limestone, 53 companies (69 quarries); granite, 13 companies (21 quarries); basalt, 9 companies (9 quarries); sandstone, 11 companies (15 quarries); marble, 1 company (1 quarry); miscellaneous stone, 5 companies (5 quarries); calcareous marl, 2 companies (2 quarries); and slate, 4 companies (4 quarries). The number of quarries does not add to the total shown above because five firms produced more than one kind of stone.

TABLE 9.—Stone sold or used by producers, by kinds and uses

Kind and use	1962		1963	
	Short tons	Value	Short tons	Value
Dimension stone:				
Granite: Miscellaneous uses			1,948	$94,453
Sandstone: All uses	1,191	$12,159	1,589	23,594
Crushed and broken stone:				
Basalt: Concrete and roadstone	2,709,440	4,641,231	[1] 2,961,972	[1] 4,590,415
Granite:				
Concrete and roadstone	5,742,998	8,963,610	6,128,677	9,651,958
Riprap	[2] 739,406	[2] 1,453,822	[3] 573,144	[3] 1,195,275
Limestone:				
Riprap	103,628	128,042	(4)	(4)
Fluxing stone	1,245,544	2,107,113	1,075,534	1,763,795
Concrete and roadstone	9,047,856	11,963,629	10,135,706	13,650,892
Railroad ballast	410,813	558,051	308,478	390,134
Agricultural	899,925	1,721,926	1,071,160	1,969,101
Miscellaneous	3,988,422	6,460,537	[1] 4,109,078	[1] 6,700,226
Sandstone: All uses	291,794	494,445	435,965	631,494
Undistributed: [5]	584,576	4,616,149	849,592	4,867,207
Total	25,765,593	43,120,714	27,652,843	45,528,544

[1] Includes riprap.
[2] Includes railroad ballast.
[3] Includes railroad ballast and miscellaneous uses.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Includes dimension and crushed and broken miscellaneous stone and slate, crushed and broken calcareous marl and marble, and shell.

Sulfur.—Sulfur was produced at the Yorktown (York County) refinery of the American Oil Co. by processing hydrogen sulfide recovered from fuel gas. Both production and shipments were more than 20 percent less than in 1962. The average value of shipments also declined.

METALS

Ferroalloys.—Production of ferromanganese by E. J. Lavino & Co. at Reusens, near Lynchburg, Campbell County, had been discontinued about mid-1962, but small quantities were sold from stock during 1963.

Gold and Silver.—Henry Cassell of Collinsville, Clifford Adams and associates located gold prospects in the Polebridge Creek section in Patrick County, about 14 miles northeast of Stuart. Assays were said to indicate favorable showings of gold and some possibilities for silver.

Iron and Steel.—The first U.S. commercial continuous steel casting plant, built by Babcock & Wilcox Co. for Roanoke Electric Corp., Roanoke, was an operating success. The unit produces approximately 700 feet of 4½-inch-square billits or cast bars from 22-ton heats. More bars also can be produced than in the conventional ingot mold method, as only the beginning and end of the total cast bar are removed, not the top and bottom of each ingot.[16]

Iron Ore (Pigment Material).—One firm near Henry, Franklin County, produced red iron oxide pigments from Minnesota hematite. Another company produced and sold crude brown and yellow oxide pigments near Hiwassee, Pulaski County. This firm also produced, near Hiwassee and Pulaski, sienna, umber, and ocher, and other natural red and yellow iron oxide pigments, and a large number of finished natural and manufactured pigments. Total sales of these iron oxide pigments decreased sharply.

Lead and Zinc.—Output of recoverable zinc declined 9 percent in tonnage from that of 1962, and value of zinc was only 7 percent less than in 1962, the previous peak year. Production came from Wythe and Rockingham Counties. Tri-State Zinc, Inc., in Rockingham County, however, discontinued the mining of zinc in July, as the ore body had been depleted. Production of lead dropped sharply. Because of a 17-percent rise in average value per ton, however, total value of lead increased slightly. Wythe County zinc-lead ores were concentrated at Austinville and Rockingham, zinc ore at Timberville. The zinc concentrate was smelted at Palmerton and Josephtown, Pa., and East Chicago, Ind. Lead concentrate was shipped to Baton Rouge, La., and La Salle, Ill.

Manganese.—Union Carbide Ore Co. continued to dry, crush, and grind imported manganese ore at its preparation plant in Newport News.

Titanium Concentrates.—Marketed production of titanium concentrate increased slightly with a moderate rise in value. Output of both ilmenite and rutile rose, although rutile increased more rapidly compared with 1962 output. American Cyanamid Co., Piney River, Amherst County, produced ilmenite and M&T Chemicals Inc., near Montpelier, Hanover County, produced ilmenite and rutile.

[16] The Commonwealth of Virginia. Steel Firm Uses New Casting Process. V. 30, No. 7, July 1963, p. 40.

TABLE 10.—Mine production of recoverable silver, lead, and zinc

Year	Silver		Lead		Zinc	
	Troy ounces	Value	Short tons	Value	Short tons	Value [1]
1954-58 (average)	1,853	$1,677	3,286	$923,046	19,163	$4,478,057
1959	866	784	2,770	637,100	20,334	4,661,792
1960			2,152	503,568	19,885	5,142,275
1961			3,733	768,998	29,163	6,726,462
1962			4,059	746,856	26,479	6,140,705
1963			3,500	756,000	23,988	5,724,628

[1] Recoverable zinc valued at the yearly average price of prime western slab zinc, East St. Louis Market. Value established after transportation, smelting, and manufacturing charges have been added to the value of ore at the mine.

REVIEW BY COUNTIES

Mineral production was reported from 74 of the 96 counties and from 3 independent cities. Output of stone was reported from 54 counties, and sand and gravel was mined in 41 counties and 3 independent cities. Government-and-contractor sand and gravel production by the Virginia Department of Highways was reported in Accomack, Alleghany, Bath, Northampton, Page, Pittsylvania, Rockbridge, Rockingham, Russell, and Shenandoah Counties. Henrico County Highway Department also produced sand and paving gravel for its own use. Washed, screened, or otherwise prepared material comprised 63 percent of all Government-and-contractor sand and gravel, and over four-fifths was consumed for paving and maintenance of roads and streets.

Limestone was produced by Virginia Department of Highways for highway construction in Augusta, Clarke, Highland, Roanoke, and Russell Counties; sandstone also was quarried in Buchanan County for roadstone by the same agency. Granite was produced and crushed by the Public Works Department of the city of Danville, Pittsylvania County, and limestone was quarried and crushed by the city of Wytheville, Wythe County, for concrete aggregate and roadstone.

TABLE 11.—Value of mineral production in Virginia, by counties [1]

County	1962	1963	Minerals produced in 1963 in order of value [2]
Accomack	$28,172	$49,856	Sand and gravel.
Albemarle	(3)	(3)	Stone, sand and gravel.
Alexandria (city)	(3)	15,035	Sand and gravel.
Alleghany	(3)	(3)	Stone, sand and gravel.
Amelia	(4)	(3)	Gem stones, stone.
Amherst	(3)	(3)	Titanium concentrate, stone, sand and gravel.
Appomattox	75,662	72,092	Stone.
Arlington	(3)		
Augusta	(3)	(3)	Cement, stone, clays, sand and gravel.
Bath	(4)	1,414	Sand and gravel.
Bedford	(3)	(3)	Stone feldspar.
Bland	8,241	16,614	Stone.
Botetourt	(3)	(3)	Cement, stone, clays, sand and gravel.
Brunswick	(3)	(3)	Stone, clays.
Buchanan	[5] 45,178,753	50,783,857	Coal, natural gas, stone.
Buckingham	2,278,130	2,540,367	Stone, kyanite, sand and gravel.
Campbell	1,393,994	1,486,867	Stone.
Caroline	(3)	(3)	Sand and gravel.
Carroll	(3)	85	Gem stones.
Chesapeake (city) [6]	(3)	(3)	Cement, lime, sand and gravel.
Chesterfield	(3)	(3)	Sand and gravel, stone, clays.
Clarke	(3)	140,860	Stone.

TABLE 11.—Value of mineral production in Virginia, by counties [1]—Continued

County	1962	1963	Minerals produced in 1963 in order of value [2]
Craig	(3)	(3)	Sand and gravel.
Culpeper	(3)	$314,405	Stone, sand and gravel.
Dickenson	[5] $35,124,727	32,886,682	Coal, natural gas, sand and gravel.
Dinwiddie	(3)	(3)	Stone, clays, gem stones.
Fairfax	5,626,859	8,082,407	Sand and gravel, stone.
Fauquier	(3)	(3)	Stone.
Fluvanna	(4)	(3)	Stone.
Franklin	(3)	9,240	Soapstone.
Frederick	3,220,508	3,977,000	Stone, lime, sand and gravel, clays.
Giles	(3)	4,394,235	Lime, stone.
Goochland	(3)	(3)	Stone.
Grayson	88,260	93,511	Stone, gem stones.
Greensville	(3)	(3)	Stone, sand and gravel.
Halifax	(3)	(3)	Stone.
Hanover	1,301,985	(3)	Stone, aplite, titanium concentrate.
Henrico	4,630,641	(3)	Sand and gravel.
Henry	(3)	(3)	Stone.
Highland	(4)	20,923	Stone, gem stones.
Isle of Wight [7]	90,584	78,150	Lime, stone, sand and gravel.
King William	(3)	(3)	Sand and gravel.
Lee	[8] 2,126,069	[9] 2,064,740	Coal, stone, petroleum.
Loudoun	3,211,042	2,918,512	Stone.
Louisa	(3)	(3)	Do.
Madison	(4)		
Mecklenburg	(3)	(3)	Stone.
Montgomery [10]	274,044	417,577	Stones, coal, clays, sand and gravel.
Nansemond	(3)	(3)	Stone, clays.
Nelson	(3)	(3)	Stone, aplite.
New Kent		(3)	Sand and gravel.
Northampton	84,065	(3)	Do.
Nottoway	(3)	(3)	Stone.
Orange	(3)	(3)	Clays.
Page		1,415	Sand and gravel.
Pittsylvania	(3)	517,739	Stone, clays, sand and gravel.
Prince Edward	(3)	(3)	Kyanite, sand and gravel.
Prince George	890,240	(3)	Sand and gravel.
Prince William	(3)	(3)	Stone, clays.
Pulaski	(3)	(3)	Stone, iron ore (pigment material).
Roanoke	[10] 1,935,163	2,469,535	Stone, clays, sand and gravel.
Rockbridge	(3)	969,368	Stone, sand and gravel, clays.
Rockingham	2,221,743	1,743,037	Stone, zinc, sand and gravel.
Russell	[11] 9,461,486	9,174,473	Coal, stone, clays, sand and gravel.
Scott	1,059,932	952,667	Stone, coal.
Shenandoah	(3)	(3)	Lime, stone, sand and gravel.
Smyth	(3)	(3)	Lime, salt, stone, sand and gravel, clays.
Spotsylvania	(3)	(3)	Sand and gravel, stone.
Stafford	(3)	(3)	Sand and gravel.
Sussex	82,705	96,720	Do.
Tazewell	[11] 1,569,685	[12] 1,636,442	Coal, stone, lime, clays.
Virginia Beach (city) [13]	460,161	505,669	Sand and gravel.
Warren	(3)	(3)	Cement, stone, sand and gravel.
Washington	3,311,512	3,277,145	Stone, gypsum, sand and gravel.
Westmoreland	72,500	69,156	Sand and gravel.
Wise	[12] 24,532,583	[14] 25,338,855	Coal, stone, sand and gravel.
Wythe	6,152,873	6,700,348	Zinc, stone, lead, sand and gravel.
York	364,408	(3)	Sand and gravel.
Undistributed [15]	65,637,698	65,247,755	
Total	222,494,000	229,065,000	

[1] The following counties did not report production: Charles City, Charlotte, Cumberland, Essex, Floyd, Gloucester, Greene, James City, King and Queen, King George, Lancaster, Lunenberg, Mathews, Middlesex, Northumberland, Patrick, Powhatan, Rappahannock, Richmond, Southampton, and Surry.

[2] Value of natural gas and petroleum included with "Undistributed" (1962).

[3] Figure withheld to avoid disclosing individual company confidential data.

[4] Included with "Undistributed."

[5] Excludes natural gas, included with "Undistributed."

[6] Effective Jan. 1, 1963, Norfolk County and the independent city of South Norfolk were annexed to the new independent city of Chesapeake.

[7] Excludes sand and gravel; included with "Undistributed."

[8] Excludes petroleum; included with "Undistributed."

[9] Excludes stone and petroleum; included with "Undistributed."

[10] Excludes clay; included with "Undistributed".

[11] Excludes stone and clays; included with "Undistributed."

[12] Excludes stone; included with "Undistributed."

[13] Effective Jan. 1, 1963, Princess Anne County was annexed to the independent city of Virginia Beach.

[14] Excludes stone and sand and gravel; included with "Undistributed."

[15] Includes value of natural gas and petroleum (1962), part of value of gem stones, and values indicated by footnote 3. Also includes value of certain quantities of Government-and-contractor limestone and commercial sandstone for which separate data by counties are not available (1962).

Accomack.—Construction sand and gravel was dredged and processed by Charles F. Matthews near Oak Hill. Unprocessed construction sand was sold by Lance J. Eller, Inc.

Albemarle.—Granite was quarried by the Superior Stone Co., division of Martin-Marietta Corp., at its Red Hill quarry. Basalt was produced by Charlottesville Stone Corp., near Charlottesville. Both basalt and granite were consumed for concrete aggregate and roadstone. Small quantities of sand for road construction and ice control were mined by two producers.

Alexandria (City).—One small producer sold processed sand for paving and ice control on roads. Production increased.

Alleghany.—W. G. Mathews, Jr., Inc., produced low-magnesium limestone for use as concrete aggregate and roadstone, and agstone (agricultural limestone) at its quarry near Clifton Forge.

West Virginia Pulp & Paper Co., Covington, regenerated lime in a natural gas-fired rotary kiln for use in its own manufacture of paper.

Amelia.—Stone & Mineral Corp. produced crushed quartz near Amelia Court House for use as architectural facing material. Specimens of amazonite, cleavelandite, albite, garnet, and other minerals were obtained by mineral specimen dealers and hobbyists from the Morefield mine near Amelia Court House and elsewhere in the county.

Amherst.—Ilmenite mined by open-pit methods near Piney River by American Cyanamid Co. was used in the company's nearby titanium pigment plant in Nelson County.

Riverton Lime & Stone Co. mined aplite (miscellaneous stone) in Amherst County until the end of March for processing in Nelson County for use as concrete aggregate and roadstone. Shipments of stone continued until December 1 when the plant was closed and the equipment sold. Production of aplite for glass manufacture was also discontinued. Smiley Sand Co., near Lynchburg, dredged and prepared sand for building purposes. Production decreased slightly.

Appomattox.—Virginia Department of Agriculture and Immigration quarried and processed limestone for use as agstone at its No. 2 grinding plant near Appomattox.

Augusta.—Shale and limestone were mined by Lehigh Portland Cement Co. for use in the manufacture of cement at Fordwick. Both general-use and high-early-strength portland cement was produced by this firm in six kilns of varying dimensions by the dry process. Also produced was a sizable tonnage of masonry cement. Both generated and purchased electric power was used. Gypsum, mill scale and pyrite cinders, and resin were purchased for use as added ingredients in cement manufacture.

Belmont Trap Rock Co., Inc., Valley Stone Co., and Augusta Stone Corp., near Staunton, produced crushed limestone for concrete aggregate. Commercial limestone produced in the county increased 14 percent over that of 1962. Virginia Department of Agriculture and Immigration mined limestone and ground it for agricultural purposes at its No. 1 grinding plant near Staunton.

Shale was mined by North Mountain Brick of Virginia at Swoope, west of Staunton, for use in making building brick. D. M. Connor Sand Co. mined and processed building sand at its stationary plant at Stuarts Draft.

Bath.—The Salem Stone Corp. limestone quarry near Hot Springs was abandoned.

Bedford.—Production of limestone at its Blue Ridge quarry by Blue Ridge Stone Corp. increased substantially over that of 1962. The product was consumed in concrete aggregate and roadstone, and as railroad ballast and stone sand. A small amount of crushed quartz for architectural facing work was produced near Bedford by Stone & Mineral Corp.

Clinchfield Sand & Feldspar Corp. mined potash and mixed soda and potash feldspar at its Mitchell, Peakesville, and Overacre mines near Bedford. Production was 28 percent less than in 1962. Sales of ground feldspar from the company mill at Bedford chiefly were for pottery and enamel manufacture. Smaller shipments for soaps and abrasives and for welding rods were reported. Feldspar shipped to Maryland, Ohio. and New Jersey comprised the bulk of the sales.

Bland.—Bland Correctional Farm, near White Gate, quarried limestone for use as riprap and agstone.

Botetourt.—Botetourt was the second largest limestone-producing county in Virginia, surpassed only by Frederick County. Production increased slightly, totaling nearly 2.0 million short tons valued at $3.0 million. Liberty Limestone Corp. operated two quarries, and James River Hydrate & Supply Co., Inc., one quarry, all near Buchanan. Eagle Rock Limestone Corp. also quarried limestone near Eagle Rock. Uses of limestone marketed by these three firms included concrete aggregate, roadstone, metallurgical flux, agstone, asphalt and fertilizer filler, railroad ballast, and stone sand. Salem Stone Corp. sold crushed limestone for concrete aggregate and roadstone; the plant, which also was near Buchanan, was abandoned during the year.

Limestone was quarried for its own use in cement manufacture by Lone Star Cement Corp. at its Cloverdale plant, where both general-use and high-early-strength portland cement was manufactured by the dry process in four 9- by 340-foot rotary kilns. Non-air-entrained cement, however, comprised the bulk of both production and shipments; masonry cement also was prepared and shipped. Purchased electricity was used. Although the largest cement plant in Virginia, shipments again declined slightly compared with those in 1962. Distribution of shipments was mostly to Virginia and North Carolina.

Botetourt County rose to first rank in production of clay among counties in the State. Production in 1963 was 6 percent greater than in 1962. Miscellaneous clay and shale for heavy clay products and lightweight aggregate, respectively, were produced by Webster Brick Co., Inc., and Weblite Corp. (formerly Virginia Lightweight Aggregate Corp.) at Webster near Roanoke. A small quantity of unprocessed gravel was sold by two producers.

Brunswick.—Southern Materials Co., Inc., quarried and crushed granite at its Rawlings quarry for use as concrete aggregate and roadstone and as stone sand. Brick & Tile Corp., near Lawrenceville, mined miscellaneous clay for use in the making of building brick.

Buchanan.—Production of coal in Buchanan County totaled 13.1 million tons, or 43 percent of the State total. It was the largest coal-producing county in the State. Active in 1963 were 883 mines, of

which 856 were underground, 8 were strip, and 19 were auger mines. Output was 10 percent higher than in 1962. The larger operators in the county included Hobbs Bros. Coal Co., Inc., Harmon Mining Corp., Island Creek Coal Co., and Jewell Ridge Coal Corp. The chief producing coal seams included Red Ash, Jewell Ridge, and Splashdam.

The Beatrice mine of The Beatrice Pocahontas Co., a joint venture of Island Creek Coal Co. and Republic Steel Corp., began limited production about the end of the year. This 1,340-foot-deep mine at Keen Mountain is to produce 1.2 million tons annually of Pocahontas No. 3 coal.

Jewell Smokeless Coal Corp. started production of beehive coke in early 1963 at its two new batteries of rectangular nonrecovery type ovens. Located at Whitewood near Vansant, the 210 ovens were operated the entire year. The product mostly was shipped to a Detroit, Mich., steel plant.

Production of natural gas by United Fuel Gas Co. totaling 1,479,776 thousand cubic feet was delivered to the pipelines of Atlantic Seaboard Co. and Hope Natural Gas Co. There was no drilling in the county.

Buckingham.—Arvonia-Buckingham Slate Co., Inc., and LeSueur-Richmond Slate Corp. quarried and prepared roofing slate, structural and sanitary slate, and flagging, near Arvonia. Slate was also quarried and prepared as roofing granules by Blue Ridge Slate Corp. at its Dutch Gap mill near New Canton. Lightweight aggregate was produced at a seven-kiln plant by Solite Corp. from slate mined near Bremo Bluff.

Kyanite Mining Corp. mined raw kyanite and prepared it by flotation at its Willis Mountain mine and Dillwyn mill, respectively, for sale to manufacturers of refractories and other ceramic products. Output of construction and industrial sand at the Willis Mountain operations increased slightly.

Campbell.—Limestone for concrete aggregate and roadstone was quarried and crushed by Rockydale Stone Service Corp., near Concord, and Blue Ridge Stone Corp., near Lynchburg. Virginia Greenstone Co., Inc., at a quarry and plant near Lynchburg, prepared rough and dressed Virginia Greenstone as building stone, refractory stone for oven hearths, and rubble. Dimensioned and random broken stone for flagging and broken fragments for riprap also were sold. A new firm, Raine Materials Co., T/A (Trading as) Lynlite Materials Co., expanded a blue-gray schist from its own property near Lynchburg for use as lightweight aggregate. Production began in February at its 150-ton-per-day plant. One 9- by 90-foot kiln was installed, and another was being constructed at yearend. A third is projected for the near future. The finished material, "Lynlite," is used for prestressed concrete, block, and roofing granules.

Small quantities of ferromanganese were sold from accumulated stocks by E. J. Lavino & Co. Production at the Reusens plant was discontinued in June 1962.

Caroline.—Production of sand and gravel increased about 25 percent. Sand and gravel was mined and processed for building and road con-

struction and fill. Small quantities of bank-run sand and gravel for building were sold.

Carroll.—Mineral collectors gathered blue corundum, unakite, and other specimens from the New River area.

Chesapeake (City) formerly the county of Norfolk.—Portland cement was produced by Lone Star Cement Corp. in South Norfolk. This firm consumed calcareous marl and clay from Nansemond County for use in its manufacturing processes. Cement was burned in three 7.7- by 219-foot kilns and one 10.5- by 340-foot kiln, producing mostly non-air-entrained cement. The wet process was used. No masonry cement was manufactured. In addition to the captive marl and clay mined, purchased materials included gypsum, iron ore, and other materials, including "vinsol" and resin.

Lime was manufactured by Reliance Fertilizer & Lime Corp. at its Norfolk plant using oystershell purchased from J. H. Miles & Co., Inc., also in Norfolk. Hydrated lime was sold for agricultural purposes. The company's four-pot kilns burned a mixture of 50 percent shell and 50 percent dolomitic limestone.

Construction sand was dredged and processed near Norfolk by Interstate Division, Commonwealth Sand & Gravel Corp.

United States Gypsum Co. calcined domestic and imported gypsum at a plant at Norfolk for plaster and other products. Gypsum also was ground for agricultural use. The Baugh Chemical Co., Chas. W. Priddy & Co., Inc., and F. S. Royster Guano Co. imported crude gypsum from Nova Scotia and ground it for use as a land dressing, chiefly by peanut farmers.

Chesterfield.—Although production decreased, the county continued to rank third among sand and gravel producing counties. Southern Materials Co., Inc., at its Kingsland Reach plant processed sand and gravel for building and road construction and for use as soil aggregate. Tidewater Crushed Stone & Asphalt Co. produced and sold granite for use as riprap, railroad ballast and concrete aggregate and roadstone at its Richmond quarry. The Bowles & Jackson operations at the Tidewater Crushed Stone Corp. quarry site in Richmond were completed in 1962, and the firm is no longer in existence.

Miscellaneous clay was mined near Richmond for the making of building brick and tile by Redford Brick Co. and Southside Division, General Shale Products Corp. Daniels Brick & Tile Co., Inc., also using a miscellaneous clay, increased its production of vitrified sewer pipe and tile at Richmond by additions to its manufacturing capacity.

Clarke.—Calcareous marl for agricultural use was mined, pulverized, and air dried by J. C. Digges & Sons, White Post. Stuart M. Perry, Inc., produced magnesium limestone at a portable plant near Berryville, for use as concrete aggregate and roadstone.

Craig.—Sand prepared for building, paving, filter beds, and industrial use was mined near New Castle by Castle Sands Co. Production increased. No crushed or broken sandstone was produced.

Culpeper.—Sandstone was crushed at its stationary plant by Culpeper Stone Co., Inc., near Culpeper, for use in concrete aggregate and as road construction material. Virginia Granite Co., Inc., a new firm, produced dimension granite for use in monuments and mausoleums at its quarry near Culpeper. Three small producers sold prepared sand for paving and ice control.

Dickenson.—Dickenson County ranked second in output of bituminous coal in Virginia, although production decreased slightly. The number of mines, however, more than doubled, totaling 169 compared with 83 in 1962. Included among the active mines were 152 underground mines, 9 strip mines, and 8 auger mines. The chief coal producers were Clinchfield Coal Co., Wisco Coal Corp., Betty B. Corp., and Contracting Enterprises, Inc. Production was chiefly from the Upper and Lower Banner, Splashdam, and Clintwood Seams.

Natural gas was produced by The Clinchfield Coal Co., division of Pittston Co., and delivered to Kentucky-West Virginia Gas Co. pipelines for local consumption. Deliveries totaled 605,170 thousand cubic feet. No new drilling was undertaken.

Bank-run sand dredged near Haysi was sold for building construction by Honaker Sand Co.

Dinwiddie.—Granite for concrete aggregate, roadstone, and riprap was quarried and crushed by Southern Materials Co., Inc., at its Jack quarry near Petersburg. A large part of this quarry's production was supplied to the Chesapeake Bay Bridge-Tunnel project. Daniels Brick & Tile Co., Inc., mined shale under contract at its Hardy shale pit for use in the making of vitrified sewer pipe and flue lining at its plant near Richmond. Production was larger than in 1962. Mineral hobbyists collected lepidolite and other minerals.

Fairfax.—Fairfax County again ranked first among sand-and-gravel-producing counties. Output totaled 3.6 million tons, a 39-percent increase over that of 1962, and constituted 34 percent of the State total. Ninety-five percent of the total tonnage was processed and 94 percent was sold for building and road construction. Large producers with stationary plants included Modern Sand & Gravel Corp., Virginia Sand & Gravel Co., Alexandria Sand & Gravel Co., and Potomac Sand & Gravel Co. George F. Dodd Corp. and Mount Vernon Gravel Co., Inc., were among the large producers having portable plants.

W. E. Graham & Sons Division, Vulcan Materials Co., produced crushed granite from a quarry and mill near Occoquan for use as riprap and roadstone. Fairfax Quarries, Inc., quarried and crushed diabase (traprock) for concrete aggregate and roadstone at its operation near Centreville and L. S. Sorber & Co. produced crushed stone near Herndon. Production of granite in the county increased substantially over that of 1962. Herbert Bryant, Inc., Alexandria, crushed oystershell for poultry grit and agricultural use.

Fauquier.—Sanders Quarry, Inc., and Chadbourn Gotham, Inc., operated basalt (traprock) quarries near Warrenton and Paris, respectively. The product was crushed and sold for concrete aggregate and roadstone. Millbrook Quarries, Inc., which was idle during 1962 and 1963, is no longer in business. W. A. Lansdowne and Will Miller, Haymarket, and Lofton Lambert, and J. W. Costello, The Plains, quarried irregularly shaped sandstone rubble and flagging for use in foundations and for facing buildings. Stone & Mineral Corp. produced broken quartz from its Hornor mine for use as architectural facing for buildings.

Fluvanna.—Stone & Mineral Corp., produced crushed quartz rock for use as architectural facing material at its Haden and Davis quarries near Nahor and Scottsville, respectively.

Franklin.—Ground soapstone was produced at its King-Ramsey mine and plant near Henry by Blue Ridge Talc Co., Inc. The chief outlets for this material were insecticides and foundry facings. Finished natural and manufactured iron oxides also were processed at a company plant at Henry.

Frederick.—Frederick County in 1963 rose to first place in both quantity and value among limestone-producing counties. Production totaled 2.0 million tons valued at $3.0 million, a 40-percent increase in production and a 28-percent increase in value over corresponding figures for 1962. W. S. Frey Co., Inc., quarried limestone at Clearbrook for use as fluxing stone for metallurgical furnaces; some tonnage also was sold for concrete aggregate and roadstone. This firm in 1963 began development of an underground mine at the same location as the quarry. Limestone was quarried and crushed at Middletown and Stephens City by M. J. Grove Lime Co., division of The Flintkote Co., for use chiefly as metallurgical flux, agstone, and in cement, lime, and glass manufacture; some stone sand and crushed stone for concrete aggregate and roadstone also were shipped. Stuart M. Perry, Inc., quarried and crushed limestone near Winchester for concrete aggregate, roadstone, agstone, stone sand, and for other uses. Salem Stone Corp. continued to produce limestone for concrete aggregate and roadstone from its quarry near Stephens City. Terra Alta Limestone Co.'s Aurora quarry was idle for the second year.

Both quicklime and hydrated lime were produced by M. J. Grove Lime Co., division of the Flintkote Co., at its Stephens City plant. The company produced construction (mason's lime and soil-stabilization lime), agricultural lime, and lime for many chemical and other industrial uses. Natural gas was used as fuel in its seven-shaft kilns and one batch and one continuous hydrator. Also used were one Azbe vertical and one Corson kiln. Sand used in glass production and small quantities for building and paving were produced at its stationary plant near Winchester by the Virginia Glass Sand Corp. Production increased over that of 1962. Shale was mined by Shenandoah Brick & Tile Corp., near Winchester, for use in the making of building brick.

Giles.—Lime was produced the entire year by the National Gypsum Co., near Kimballton. Standard Lime & Cement Co., division of Martin-Marietta Corp., produced lime until October 31 when the plant was purchased by Foote Mineral Co., Exton, Pa. The latter firm operated the kilns for the balance of the year. Markets chiefly were for chemical and industrial uses, although some mason's lime and agricultural lime were produced. Lime-burning equipment for these two firms comprised five coal-fired rotary kilns and one continuous hydrator. Ripplemead Lime Co., Inc., now Ripplemead Limestone Co., division of Fincastle Co., Ripplemead, was idle.

In partial response to a Federal Trade Commission order, Standard Lime & Cement Division of Martin-Marietta Corp. agreed to sell two lime plants to Foote Mineral Co. One of these was the Kimballton, Va., plant, including the mining operations. Foote was expected to take possession on or about November 1, and was to expand output of lime for basic oxygen furnace use and other chemical, industrial, and building purposes.

Limestone was quarried and processed for use in lime manufacture, as concrete aggregate, and roadstone, and as coal-mine dust by Virginian Limestone Corp., and Ripplemead Limestone Co., Division of The Fincastle Co., near Ripplemead, and National Gypsum Co., and Foote Mineral Co., formerly Standard Lime & Cement Co., division of Martin-Marietta Corp. (both near Kimballton). Total output in Giles County was somewhat greater than in 1962. Minerals Development Co. continued its iron ore exploration program in Giles County.

Goochland.—Boscobel Granite Corp. and W. E. Graham & Sons, division of Vulcan Materials Co. quarried granite for use as concrete aggregate and roadstone at their Manakin and Royal Stone quarries, respectively.

Grayson.—Crushed stone was produced by Grayson Stone Corp. for use as concrete aggregate and roadstone at its quarry near Fries. Mineral collectors found specimens of olivine and other minerals near Galax.

Greensville.—Granite was crushed and quarried by Trego Stone Corp. at a quarry near Skippers for use as concrete aggregate and roadstone, Paving gravel was mined and processed by one producer.

Halifax.—Granite for concrete aggregate and roadstone was quarried at South Boston by W. E. Graham & Sons, division of Vulcan Materials Co.

Hanover.—The General Crushed Stone Co. produced granite at its Verdon quarry near Doswell for concrete aggregate and roadstone and railroad ballast.

Ilmenite, rutile, and aplite (for glass manufacture) were produced by M&T Chemicals, Inc., at its Beaver Dam plant near Montpelier.

Henrico.—Output of sand and gravel increased, totaling 1.9 million tons, and Henrico County continued to rank second among sand-and-gravel-producing counties. Ninety-eight percent of commercial production was processed and sold mainly for building and road construction. Quantities were also used for fill and septic tank drain fields. Southern Materials Co., Inc., continued to operate its Dredge No. 12 on the James River. West Sand & Gravel Co., Inc., and Carter Sand & Gravel Co., Inc., both at Richmond, were among producers operating stationary plants.

The new 800,000-ton-per-year Mankin processing plant of West Sand & Gravel Co., near Highland Springs, was placed in operation in April. All plant controls are centralized at one station, so that one man can control the entire operation. A complete and detailed description of the highly automated plant was published; it includes accounts of the layout (with diagram), the automatic blending and loading systems, crushing and screening operations, and photographs of plant equipment.[17]

Henry.—Martinsville Stone Corp., Snyder Stone Quarry, and A. C. Wilson Construction Co. produced and crushed granite near Martinsville for concrete aggregate and road construction.

Highland.—Agate and other minerals were collected by hobbyists near Hightown.

---

[17] Bergstrom, John H. Triple Threat Aggregate Plant. Rock Products, v. 66, No. 10, October 1963, pp. 54–55, 57–58.

Isle of Wight.—Lime was burned from oystershell obtained as a by-product of oyster cannery operation by Battery Park Fish & Oyster Co. The product was hydrated and sold for agricultural purposes. Bituminous coal-fired-pot kilns were employed in burning the lime. A small quantity of bank-run sand was produced for paving fill.

King William.—There was a large decrease in sand and gravel production. One producer reported mining and processing sand and gravel for building and paving purposes.

Lee.—Bituminous coal production in Lee County was 11 percent greater than in 1962, although the number of mines decreased from 87 in 1962 to 81 in 1963. Of these, 77 were underground mines, 1 was a strip mine, and 3 were auger mines. Underground operations accounted for 92 percent of the county production. Included among the chief producing coal companies were Darby Fuels, Inc., Mason Coal Co., and Dean Jones Coal Co. Production largely was from the Darby No. 5 and Marker seams.

Kentucky-Virginia Stone Co., Inc., quarried limestone for concrete aggregate, roadstone, agstone, coal-mine dust, filtration, and other uses at its Wheeler quarry near Gibson Station. Woodway Stone Co., Woodway, produced high-calcium limestone for railroad ballast, agstone, and lime manufacture.

The Rose Hill field was the only oil-producing area in the State. Production totaled 3,466 barrels. A new small oil well was completed in the Trenton limestone, a short distance south of Ben Hur and about 19 miles northwest of the Rose Hill field. One test well was plugged and abandoned in the Rose Hill field.

Loudoun.—The county was the chief basalt-producing county in the State and ranked third in both tonnage and value among all stone-producing counties. Production totaled 1.7 million tons, slightly under 1962 output. Chantilly Crushed Stone, Inc., Chantilly, near Arcola; Virginia Trap Rock, Inc., Leesburg; Arlington Stone Co., Leesburg; and Bull Run Stone Co., Inc., near Manassas, all produced basalt (trap rock) for use in highway construction and maintenance and for building purposes.

Louisa.—Superior Stone Co., division of Martin-Marietta Corp., produced crushed limestone at Gordonsville for concrete aggregate and roadstone.

Mecklenburg.—W. E. Graham & Sons, division of Vulcan Materials Co., produced crushed granite at its Buggs Island quarry for use chiefly as riprap and concrete aggregate and roadstone. Production was less than that in 1962.

Montgomery.—Montgomery Limestone Corp. quarried limestone at its Shawsville and Ellett quarries, near Christianburg. Uses included concrete aggregate and roadstone for the Shawsville quarry and railroad ballast and agstone for the Ellett quarry. A third quarry operated by this corporation was the former Velvet Sand Co. mine at Ironto, now operated as its Ironto Sand Co. Division, and in 1963 produced crushed sandstone for concrete aggregate and roadstone. Lambert Bros. Co. Division of Vulcan Materials Co. opened a new limestone quarry near Radford for the production of highway construction and maintenance aggregates.

Old Virginia Brick Co., Inc., mined shale near Elliston for use in the manufacture of building brick. One producer mined a small quantity of sand for road construction.

A small amount of semianthracite was produced from the Brushy Mountain and Big Vein Seams by two producers, of which Jones & Keister Coal Co., Inc., was the larger.

Nansemond.—Lone Star Cement Corp. mined calcareous marl at Chuckatuck. This firm also dredged clay from the Nansemond River near Oakland. These two materials were used in the manufacture of cement at South Norfolk, in the city of Chesapeake.

Miscellaneous clay was produced near Suffolk by Webster Brick Co., Inc., and consumed in the manufacture of building brick.

Nelson.—Alberene Stone Division of the Georgia Marble Co. quarried dimension soapstone near Schuyler. The chief products were laboratory and architectural stone and flagging. Output was slightly less than in 1962.

Aplite was mined and processed mostly for glass manufacture by Consolidated Feldspar, department of International Minerals & Chemical Corp., near Piney River. Ground aplite was shipped to glassmakers in New Jersey, Ohio, West Virginia, Illinois, and many other Southern and Eastern States. Crude rock from Amherst County was prepared at a Nelson County mill by Dominion Minerals Division, Riverton Lime & Stone Co. Preparation of aplite for use in glass manufacture was discontinued at the end of 1962, and production for concrete aggregate and roadstone ceased at the end of March. Shipments, however, for concrete and roadstone were made from stock until December 1, when the plant was closed and the equipment sold. Buffalo Mines, Inc., at Piney River dismantled its plant and went out of business.

New Kent.—J. R. Parker & Co., Inc., produced and processed sand and gravel at its stationary plant near Providence Forge for use in building and road construction. A small producer mined gravel for paving.

Norfolk.—See Chesapeake (City).

Northampton.—Southern Materials Co., Inc., continued to wash and screen paving sand, produced at its Eastern Shore portable sand plant, for the nearly completed Chesapeake Bay Bridge-Tunnel.

Nottoway.—Burkeville Stone Corp. produced crushed granite from its quarry at Burkeville for highway road construction and concrete aggregate.

Orange.—Shale and mudstone were mined by Webster Brick Co., Inc., at Somerset, near Orange, for manufacturing building brick. Production increased substantially compared with that of 1962. A description of the mining, milling, and burning operations of this company's soft-mud brick manufacturing plant was published.[18] This colonial-type brick now comprises more than one-third of the plant's 800,000 brick production.

Patrick.—Henry Cassell, of Collinsville, prospected for gold about 14 miles northeast of Stuart in the Polebridge Creek section of the county. The operation, organized by Cassell, Clifford Adam and

[18] Mohler, Neal. Soft-mud Brick: A "Sleeper" for Increased Sales. Brick & Clay Record, v. 142, No. 3, March 1963, pp. 43–45.

three associates, was named the Polebridge Creek Gold Mine, expected to be in production in 1964.

Pittsylvania.—Superior Stone Co., division of Martin-Marietta Corp., and W. E. Graham & Sons, division of Vulcan Materials Co., produced crushed stone for concrete aggregate and roadstone at quarries near Danville and Chatham, respectively.

Virginia Solite Corp. mined shale along the Virginia-North Carolina State line for use in the manufacture of lightweight aggregate at its nearby plant. The larger share of the output was from Virginia. Sand was dredged by portable draglines and prepared for construction purposes by the Kendall Sand Works and by Marshall Sand & Gravel Co., Danville.

Prince Edward.—Kyanite Mining Corp. produced kyanite at its Baker Mountain mine and prepared it by flotation at its Cullen plant. Concentrates from the Cullen and Dillwyn flotation plants were ground for special applications at Pamplin. High-temperature refractories and special ceramic bodies were the chief uses for this material. Construction and industrial sand also was produced at Baker Mountain.

Prince George.—Sand and gravel output was sold mainly for road construction. Other uses included building construction and fill. Among producers were Southern Materials Co., Inc., Puddledock Plant, and Hitch Gravel Corp.

Nitrogen compounds for use in fertilizer were manufactured by the Nitrogen Division, Allied Chemical Corp., Hopewell. Included among the products made by this firm were ammonia, urea solution, ammonium nitrate-limestone, solid and solution ammonium nitrate, and ammonium sulfate.

Virginia Perlite Corp. expanded Colorado perlite at Hopewell for building plaster, concrete aggregate, and soil conditioning. Sales were less than in 1962, although perlite sold for concrete aggregate increased.

Prince William.—Woodbridge Clay Products Co. mined and prepared miscellaneous clay for the manufacture of building brick. Production showed a moderate increase over that of 1962. This firm recently added to its facilities a new 3,300-ton clay storage building as well as 60-foot by 100-foot extensions at either end of an existing large storage shed.

W. E. Graham & Sons, division of Vulcan Materials Co., quarried and crushed stone at Manassas and Gainesville for concrete aggregate and roadstone; a small quantity of riprap was marketed. McCanless Construction Co., Inc., produced a miscellaneous rock material for road base at a quarry near Middleburg.

Princess Anne.—See Virginia Beach (City).

Pulaski.—Limestone quarried in Pulaski County near Radford by Radford Stone Corp. was crushed at the corporation's stationary plant in Montgomery County. The chief uses were in concrete aggregate and roadstone and as masonry and concrete stone sand; other uses were railroad ballast and agstone. Salem Stone Corp. also produced limestone for concrete aggregate and roadstone at its Newbern quarry. This quarry was permanently abandoned during 1963. The New

River quarry of Montgomery Limestone Corp. also is no longer in operation.

American Pigment Corp. sold crude metallic brown pigment, sienna, umber, and natural yellow iron oxide, mined near Hiwassee. Finished iron oxide pigments, including manufactured brown, red, and yellow pigments, were produced at the company's Pulaski plant. Finished metallic brown, raw and burnt sienna, raw and burnt umber, and ocher also were produced near Hiwassee.

Roanoke.—Limestone for concrete aggregate and roadstone and agstone was produced by Rockydale Quarries Corp. at its Rockydale quarry and Blue Ridge Stone Corp., both near Roanoke, and Salem Stone Corp. at two quarries near Salem and Roanoke, respectively. The Salem Stone Corp. permanently abandoned these two quarries, however, before the yearend.

Shale for making building brick was produced by Old Virginia Brick Co., Inc., near Salem. Production again was higher than in 1962. A small quantity of gravel was sold for road construction.

Rockbridge.—Limestone was quarried and crushed for concrete aggregate and roadstone by C. W. Barger & Son Limestone Quarry, Inc., near Lexington. Lone Jack Limestone Co., Inc., Glasgow, operated nearby quartzite and limestone quarries for concrete aggregate and road materials and railroad ballast. A detailed description was published of the habits, characteristics (color, luster, translucency)), associations, and interrelationships of the 26 definitely or tentatively identified minerals occurring at the Lone Jack quarries near Glasgow.[19] The quartzite plant of W. G. Mathews Jr., Inc., Natural Bridge Station (Greenlee) was idle the entire year.

Locher Brick Co., Inc., mined miscellaneous surface clay under contract near Glasgow for use in manufacturing building brick. The mining was contracted to Charles W. Barger & Son, Lexington. Sand was mined and processed for construction and industrial purposes.

Rockingham.—Tri-State Zinc, Inc., mined and concentrated zinc ore in the first half of the year at its Bowers-Campbell operation near Timberville. As the ore body had been worked out, however, this mine and mill ceased operation in July. Zinc concentrate was shipped for treatment to the Josephtown, Pa., smelter of St. Joseph Lead Co.

R. Y. Frazier and Fred K. Betts III, Quarry, Inc., mined and crushed limestone near Harrisonburg for concrete aggregate and roadstone. Limestone also was quarried and processed by C. S. Mundy Quarries, Inc., near Broadway. Uses reported by this firm included concrete aggregate and roadstone, agstone, and cement and lime manufacture. Jamison Black Marble Co., division of General Stone & Materials Corp., crushed marble for use as terrazzo near Harrisonburg. There was a large increase in sand and gravel production. Building sand and building and paving gravel were mined and processed by Grottoes Sand & Gravel Co., Inc., Grottoes.

Russell.—Output of coal in Russell County decreased by 6 percent compared with that of 1962. Underground mining accounted for 98 percent of the total production. The chief producing companies were Clinchfield Coal Co., Pine Creek Coal Co., and Smith Coal Co. Seams

[19] Dietrich, R. W. Minerals From the Lone Jack quarry, Rockbridge County, Virginia. Miner. Ind. J., v. 10, No. 1, April 1963, pp. 1–6.

mined included chiefly the Upper and Lower Banner, Red Ash, and Tiller.

Limestone was quarried and crushed for use in road construction and maintenance by Clinch River Quarries, near St. Paul. Other uses included asphalt filler and filter bed stone. Shale used in the making of lightweight aggregate by the Lightweight Aggregate Division, Clinchfield Coal Co., increased by about 20 percent compared with that of 1962. The raw material was obtained as a byproduct from the coal preparation plant of the Moss No. 2 mine of the Clinchfield Coal Corp. near South Clinchfield.

Scott.—Tri-State Lime Co., Blountville, Tenn., produced limestone for concrete aggregate and roadstone, agstone, fertilizer filler, and filtration use. Natural Tunnel Stone Co., Glenita near Clinchport, produced limestone for concrete aggregate and railroad ballast. Penn-Dixie Cement Corp. produced limestone at its Speers Ferry quarry for captive use at its Kingsport, Tenn., cement plant. Captive limestone, obtained from an underground mine near Duffield by Foote Mineral Co., was used in manufacturing lithium hydroxide at its spodumene processing plant at Sunbright.

Coal was produced in Scott County by one underground and one strip mine. Production was small.

Exploration drilling for oil and gas in Scott County included two wells, one of which was near Duffield. The other, near the center of the old Early Grove gasfield, was drilled to 7,222 feet through the Clinch Sandstone with rotary tools by Tidewater Oil Co. and South Penn Co. The hole was temporarily plugged and the well sold.

Shenandoah.—Limestone quarried by Chemstone Corp. near Strasburg was used chiefly in the manufacture of quicklime and hydrated lime. Lime was fired in four gas-fired shaft kilns and a continuous hydrator, and was sold principally as a flux in electric furnace steel manufacture and in the manufacture of paper. Water purification and softening and sewage and trade-wastes treatment were the other chief uses. Pennsylvania, Maryland, and Ohio were the chief consuming States.

Dominion Division of Chemstone Corp. operated the Lease quarry near Strasburg; the Fee quarry, operated separately in 1962, was combined with the Lease quarry operations. Limestone produced at this quarry was used chiefly as a metallurgical flux in blast furnaces and open-hearth plants and in lime manufacture. Road construction and asphalt filler were other uses. Shenandoah Valley Lime & Stone Corp., Strasburg, produced high-calcium limestone for flux, chiefly in blast furnaces and open-hearth steel plants. Kipps Magnesium Limestone Quarry, operated by Nenetah K. Kipps, Mount Jackson; Toms Brook Lime & Stone Co., Inc., Toms Brook; and C. S. Mundy Quarries, Inc., Timberville, quarried and crushed limestone for concrete aggregate, road construction, and agstone.

Smyth.—Limestone quarried from its Worthy mine near Saltville by Chemicals Division, Olin-Mathieson Chemicals Corp., was used chiefly for making lime at the company kilns, also near Saltville. The lime plant comprised 3 rotary and 14 vertical coal-and-coke-fired kilns. Salt brine from the company's nearby salt wells was combined with

captive quicklime to manufacture chlorine, soda ash, and other chemicals.

Crushed limestone for concrete aggregate and roadstone was produced by Holston River Quarry, Inc., near Marion. The Sanders Limestone quarry operated by Cardinal Construction Co. was abandoned. Crushed rock was produced by Ararat Rock Products Co., a new firm, near Marion for use as roadstone. The underground Locust Cove Gypsum mine, developed by United States Gypsum Co., about 18 miles from Saltville, was not yet in production in 1963.

Production of sand and gravel totaled 51,847 tons, a decrease of 58 percent from 1962 output. Three producers reported output, including C. R. Snider & Sons Sand Co. and Sayers Sand Co., both near Marion. Total output was washed and screened for building and road construction. The sand operation of the Sugar Grove Sand & Lime Co. was closed and dismantled in 1962. Appalachian Shale Division, General Shale Products Corp. (formerly Appalachian Shale Products Co.), mined shale near Marion for use in the manufacture of building brick.

Spotsylvania.—Fredericksburg Stone Co., Fredericksburg, produced crushed granite for concrete aggregate and roadstone. Output of sand and gravel increased. Construction sand and gravel was mined and processed by the Massaponax Sand & Gravel Corp. at its stationary plant near Fredericksburg.

Stafford.—Sand and gravel for building, paving, and miscellaneous uses was mined and processed by Fredericksburg Sand & Gravel Co., Inc., near Fredericksburg. Bank-run sand for building and railroad ballast was produced by Jobe Newton, Fredericksburg.

Sussex.—Sand and gravel for road construction was mined and prepared by Adams Construction Co. at its stationary plant near Stony Creek. Output totaled 110,013 tons compared with 46,144 in 1962.

Tazewell.—Although production of coal was larger in 1963, Tazewell County dropped from fifth to sixth among coal-producing counties. Twenty active mines were operating, including 15 underground mines, 2 strip operations, and 3 auger mines. Only 48 percent of the county's production was from underground mines, while 31 percent came from auger mines. Leading producers were Southeastern Mining Co., Alfredton Coal Co., and Wildcat Coal Co. The Upper Seaboard, Jawbone, and Red Ash seams were the chief seams mined.

Pounding Mill Quarry Corp. produced crushed limestone chiefly for concrete aggregate and roadstone at Bluefield and Pounding Mill. Other uses included metallurgical flux, agstone, railroad ballast, coalmine dust, and stone sand.

Limestone quarried by Peery Lime Co., Inc., North Tazewell, and Blue Grass Lime Co., Maxwell, was consumed in the companies' own line kilns in the manufacture of hydrated lime. The pot kilns used coal as fuel. Production was consumed as mason's lime and agricultural lime. Output was shipped to Virginia and neighboring States, including North Carolina, Tennessee, and West Virginia.

General Shale Products Corp. mined shale from an open pit near Richlands for use in making building brick. Production was slightly higher than in 1962.

Virginia Beach (City), formerly Princess Anne County.—Output of sand totaled 812,023, a 21-percent decrease from that of 1962. The city, however, continued to rank fourth among sand-and-gravel-producing areas in the State. Building and road construction and fill were the principal uses. A small quantity was sold for industrial use. E. V. Williams Co., Inc., was the leader among the producers. There was no gravel production reported. Princess Anne County was incorporated into city of Virginia Beach on January 1, 1963.

Warren.—A shaly limestone was quarried by Riverton Lime & Stone Co., Inc., Riverton, for use in the manufacture of masonry cement. Although the bulk of the finished product was shipped to Virginia, North Carolina, and the District of Columbia, distribution included many Eastern and Southern States. Riverton Lime & Stone Co., Inc., also quarried limestone for use in highway maintenance and for agstone. Skyline Crushed Stone Co., near Front Royal, was closed permanently. J. B. Earle produced crushed quartzite pebbles at his pit near Front Royal for use in concrete aggregate and roadstone. One small producer mined processed paving sand.

Washington.—Washington County ranked fifth in size of limestone output among limestone-producing counties in Virginia. Production was somewhat less than in 1962. Companies producing crushed limestone, chiefly for concrete aggregate, roadstone, and agstone, were Acme Stone Co., Inc., division of Lambert Bros., Inc., Abingdon; Washington County Stone Co., Glade Spring; Meadowview Lime Co., Meadowview; and Lambert Bros. Co., Inc., division of Vulcan Materials Co. at Bristol and Glade Spring.

Gypsum was mined and processed by United States Gypsum Co. at Plasterco. Salable products included plasterboard and other gypsum manufactures for distribution chiefly to the construction industries.

Three producers mined and prepared gravel for road construction. A small quantity of paving sand was mined.

Westmoreland.—Building sand and gravel for paving and other uses was produced by Potomac Sand & Gravel Co. at Coles Point.

Wise.—Output of bituminous coal in Wise County totaled 6.2 million tons, slightly over the 1962 level. The county produced 20 percent of the coal mined in Virginia and was first in production of strip-mined coal. The number of mines remained virtually stationary compared with the number in 1962, totaling 290. Of the active mines, 262 were underground mines, 13 were strip mines, and 15 were auger mines. Underground mines accounted for 73 percent of the total tonnage and strip mines for 20 percent. The leading coal producers included Stonega Coke & Coal Co., Coal Processing Corp., Stamach Mining Corp., Stallard-Womack Mining Corp., and Sunrise Coal Co., Inc. Important producing seams were Kelly-Imboden, Upper Banner, Clintwood, and Blair.

The five companies producing beehive coke in Wise County in 1963 were Christie Coal & Coke Co., Esserville; Hawthorne Coke & Mining Co., Hawthorne; Norton Coal Co., Inc., Norton; Stonega Coke & Coal Co., Pine Branch; and Wise Coal & Coke Co., Dorchester. Rectangular or Mitchell ovens totaled 180, and the remainder were conventional dome beehive ovens.

Southwest Quarries, Inc., Big Stone Gap, quarried and crushed limestone for concrete aggregate and roadstone. A small quantity of building sand was mined, washed, and screened.

Wythe.—Output of lead declined in 1963, although the value rose because of a 17-percent increase in average value per ton. Production of zinc, however, was somewhat higher than in 1962. Zinc and lead ores from both the Ivanhoe and Austinville mines were treated at the New Jersey Zinc Co.'s smelter at Austinville (Ivanhoe mine ore was conveyed through an underground tunnel to the smelter). Zinc concentrate was treated at the Palmerton, Pa., smelter of The New Jersey Zinc Co., the East Chicago, Ind., smelter of Grasseli Chemicals Dept., E. I. du Pont de Nemours & Co., Inc., and the Josephtown, Pa., smelter of St. Joseph Lead Co. Lead concentrate was shipped to Matthiessen & Hegeler Zinc Co., La Salle, Ill., and to Schuylkill Products Co., Baton Rouge, La. No byproduct silver was reported.

H. D. Crowder & Sons, Austinville, and Pendleton Construction Corp., Wytheville, produced crushed limestone for concrete aggregate and road material. Finely divided limestone recovered as a byproduct from lead and zinc concentration at The New Jersey Zinc Co. smelting operations at Austinville was marketed chiefly for agricultural purposes, although some material was sold for road making and as fertilizer filler. Carroll Rock Co., Wytheville, and Newman Bros. Quarry, Inc., Sylvatus, operated quarries for the production of crushed sandstone used in road construction and maintenance. Sand was produced and prepared for masonry use by Silica Products Co.

York.—Southern Materials Co., Inc., near Seaford, mined and processed sand at its York Sand plant for building and road construction. A new reporting producer, Presson & Brandt, mined and sold bank-run sand for fill.

Production and value of sulfur recovered at the American Oil Co.'s Yorktown refinery were more than one-fifth less than in 1962. The sulfur was obtained by conversion of hydrogen sulfide from fuel gas.

The Mineral Industry of Washington

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Washington Division of Mines and Geology for collecting information on all minerals except fuels.

By Jerry J. Gray [1] and William N. Hale [2]

MINERAL production in Washington was valued at $71.4 million in 1963, 4 percent more than in 1962. Major mineral commodities having substantial increases in output were lime (150 percent), magnesite (28 percent), sand and gravel (16 percent), uranium ore (6 percent), gold (5 percent), and zinc (3 percent). Coal (19 percent) and lead (11 percent) were the only major commodities with substantially lower production.

Nonmetal industries were expanded when Pacific Lime Co. began production early in the year at its new lime plant at Tacoma. Olivine

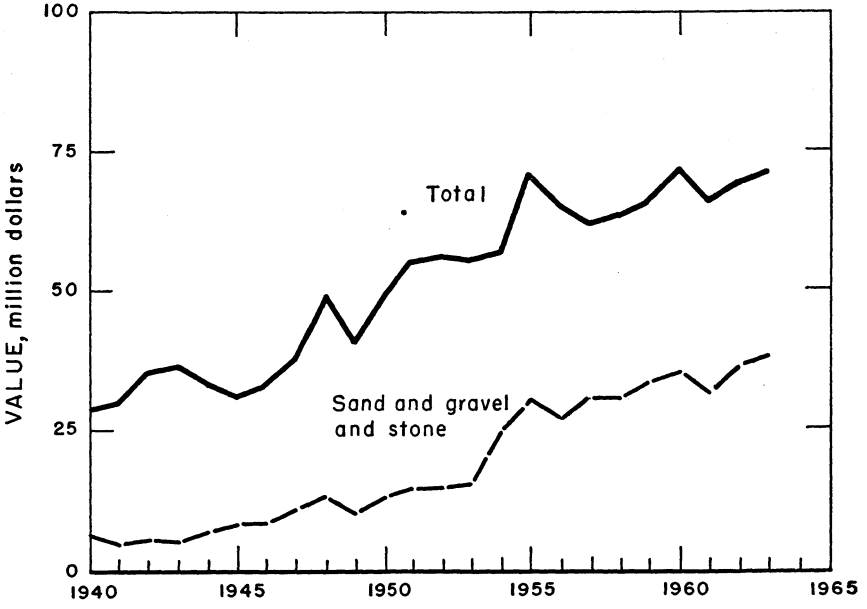


FIGURE 1.—Value of sand and gravel and stone, and total value of mineral production in Washington, 1940–63.

[1] Geologist, Bureau of Mines, Albany, Oreg.
[2] Mineral specialist, Bureau of Mines, Albany, Oreg.

747-416—64——73

TABLE 1.—Mineral production in Washington [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasive stone (grinding pebbles)—short tons	(2)	(2)	5	(3)
Clays [4]—thousand short tons	103	$100	134	$123
Coal (bituminous)—do	235	1,630	190	1,380
Copper (recoverable content of ores, etc.)—short tons	41	25	(2)	(2)
Lead (recoverable content of ores, etc.)—do	6,033	1,110	5,374	1,161
Peat—do	[5] 41,962	288	37,248	188
Pumice—thousand short tons	10	130	(2)	(2)
Sand and gravel—do	19,580	18,145	22,760	20,490
Stone—do	12,749	18,180	12,934	16,346
Talc and soapstone—short tons	2,835	11	2,969	18
Uranium ore—do	110,948	2,050	117,286	2,545
Zinc (recoverable content of ores, etc.)—do	21,644	4,978	22,270	5,122
Value of items that cannot be disclosed: Barite (1962), carbon dioxide, cement, diatomite, epsomite, gem stones, gold, lime, magnesite, olivine, silver, and values indicated by footnote [2]		21,827		24,057
Total		68,474		71,430

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Less than $500.
[4] Excludes fire clay; included with "Value of items that cannot be disclosed."
[5] Revised figure.

Corp. (a new producer) announced plans to install olivine-processing equipment at Bellingham.

Coal mining ended in the Roslyn area, Kittitas County, after 77 years of production, when the Northern Pacific Railway Co. closed the Roslyn mines. The closure resulted from declining demand.

Future expansion of the nonferrous smelting and refining industry of the State was indicated when Harvey Aluminum, Inc., and Standard Magnesium Corp. announced plans to build primary magnesium plants at Port Angeles and Vancouver, respectively.

Production of uranium ore ended in Washington in 1963 when Dawn Mining Co. shut down the Midnite mine, Stevens County, after 6.5 years of operation.

A constant dollar series has been prepared in which the bias caused by price-level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series was constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$60,305	1958	$61,932
1953	56,244	1959	64,565
1954	55,179	1960	71,383
1955	66,173	1961	66,355
1956	57,207	1962	68,196
1957	60,608	1963	70,493

TABLE 3.—Indicators of Washington business activity

	1962	1963 [1]	Change, percent
Personal income:			
Total—million dollars	7,471.0	7,639.0	+2.2
Per capita—dollars	2,482.0	2,505.0	+.9
Construction activity:			
Building permits—million dollars	440.9	417.5	−5.3
Heavy engineering awards—do	225.4	333.9	+48.1
State highway commission:			
Value of contracts awarded—do	71.1	79.6	+11.1
Value of contract work performed—do	59.8	75.0	+25.4
Cement shipments to and within Washington—thousand 376-pound barrels	4,983.0	5,223.1	+4.8
Cash receipts from farm marketings—million dollars	575.0	599.7	+4.3
Factory payrolls—do	1,509.8	1,533.5	+1.6
Annual average labor force and employment:			
Total labor force—thousands	1,125.3	1,129.4	+.4
Unemployment—do	60.4	67.0	+10.9
Employment:			
Construction—do	44.7	43.2	−3.4
Aircraft—do	73.3	64.4	−12.1
Lumber and wood products—do	42.9	42.6	−.7
Food processing—do	26.9	26.3	−2.2
All manufacturing—do	232.6	223.2	−4.0
All industries—do	1,064.5	1,060.3	−.4

[1] Preliminary figures.

Sources: Survey of Current Business, Construction Review, Pacific Builder and Engineer, Washington State Highway Commission, The Farm Income Situation, Washington Employment Security Department, and Bureau of Mines.

Primary aluminum production totaled 439,144 tons, the highest in 6 years. To meet increased demand for the light metal, potlines were reactivated at the Vancouver and Wenatchee plants by Aluminum Company of America (Alcoa) and at the Mead aluminum reduction plant of Kaiser Aluminum & Chemical Corp.

Legislation and Government Programs.—A new State law provided that a locator of a mining claim can file on geophysical and geochemical evidence, after which 3 years are allowed to complete the discovery. Formerly, the discovery shaft had to be completed before the mining claim could be staked and filed. The change was made to encourage prospecting. Washington State Division of Mines and Geology published three general interest reports concerning geology, caves, and the marketing of minerals.[3]

Consumption, Trade, and Markets.—Business indicators exhibited both gains and losses. The indicators showing gains were related to the heavy construction industry. Two power-related contracts, one for two steam-turbine generators and accessories at the Hanford project ($18 million) and the other for the Columbia River Wells Dam, Douglas County ($51 million), were the major causes of the 48-percent increase in value of heavy engineering awards. The other indicators of heavy construction also rose but not at such a substantial rate. A few unrelated events caused most of the remaining indicators to fall. The curtailment of Seattle's aerospace industry, the 1962 closing of the Century 21 World's Fair, and a labor dispute in the

[3] Anderson, Donald L. Marketing of Metallic and Nonmetallic Minerals. Washington Div. of Mines and Geol., Inf. Circ. 39, 1963, 39 pp. Halliday, William R. Caves of Washington. Washington Div. of Mines and Geol., Inf. Circ. 40, 1963, 132 pp. Livingston, Vaughn E., Jr. (reviser). A Geologic Trip Along Snoqualmie, Swauk, and Stevens Pass Highways. Washington Div. of Mines and Geol., Inf. Circ. 38, 1963, 51 pp.

lumber and wood products field affected both employment and income, which caused a decrease in the value of building permits. Cash receipts from farm marketings increased 4.3 percent.

The Bonneville Power Administration continued its economic base study to project power markets in the Pacific Northwest. As part of the study the Bureau of Mines, Office of Mineral Resources, prepared economic reports on ferroalloys, copper, lead, zinc, magnesium, sulfur, and phosphate rock.

Employment and Injuries.—Annual employment in the mineral industries was about the same as in 1962 except for the aluminum and miscellaneous categories, each of which gained over 500 employees. In the smelting, rolling, drawing, and casting of aluminum classification, the gain was due to industrial expansion, both in the reactivation of reduction potlines and in the installation of new milling and casting equipment. The gain in the miscellaneous category was due to the reclassification of one large employer from fabricated metal products (not carried in table 4) to the primary and secondary ferrous metal classification.

TABLE 4.—Annual employment and total wages in the mineral industries

Industry	1962		1963	
	Employment	Wages (thousands)	Employment	Wages (thousands)
Mining:				
Metal mining	594	$3,730	567	$3,656
Bituminous coal, crude petroleum, and natural gas	282	1,836	280	1,845
Nonmetallic mining and quarrying	1,015	6,695	1,055	7,316
Total	1,891	12,261	1,902	12,817
Stone, clay, and glass products:				
Cement, hydraulic	503	3,379	505	3,457
Structural clay products	285	1,696	252	1,430
Concrete, gypsum, and plaster products	3,590	22,881	3,664	24,447
Other	799	5,114	902	5,741
Total	5,177	33,070	5,323	35,075
Smelting, refining, and casting:				
Blast furnaces, steelworks, rolling and finishing mills	1,477	10,133	1,511	10,588
Iron and steel foundries	933	5,670	925	5,966
Smelting, refining, and casting of nonferrous metals, except aluminum	1,009	6,208	1,073	6,654
Smelting, rolling, drawing, and casting of aluminum	6,028	44,004	6,558	48,487
Miscellaneous [1]	54	367	732	5,212
Total	9,501	66,382	10,799	76,907
Industrial chemicals [2]	8,953	74,254	9,219	78,170
Petroleum refining and related industries	1,251	9,243	1,284	9,752
Grand total	26,773	195,210	28,527	212,721

[1] Gain in 1963 due to an administrative industrial reclassification of 1 large employer from fabricated metal products to the primary and secondary ferrous metal classification.
[2] The Hanford atomic plant is the largest in this classification.

Source: Washington Employment Security Department bulletins on industries covered by Washington State Employment Security Act. Industry groups may differ from those in the Bureau of Mines convass.

TABLE 5.—Injury experience in the mineral industries

Year and industry	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1962:						
Quarries and mills [1 2]	925	199	1,469,248	----------	15	10
Nonmetal mines and mills	192	115	175,872	1	6	40
Sand and gravel operations [2]	926	173	1,280,986	2	26	22
Metal mines and mills	492	243	955,245	1	42	45
Coal mines	205	211	346,749	----------	79	228
Total	2,740	193	4,228,100	4	168	41
1963: [3]						
Quarries and mills [1 2]	867	207	1,437,929	----------	19	13
Nonmetal mines and mills	208	180	299,513	----------	9	30
Sand and gravel operations [2]	849	190	1,288,526	1	28	23
Metal mines and mills	405	270	876,368	----------	48	55
Coal mines	196	191	300,098	----------	65	217
Total	2,525	208	4,202,434	1	169	40

[1] Includes cement- and lime-processing plants.
[2] Includes only commercial operations.
[3] Preliminary figures.

Water.—The results of a 1962 survey of water requirements for the mineral industry (exclusive of smelters, refineries, and cement plants) indicated that approximately 9 billion gallons of water were required for mining and processing mineral commodities.

Approximately 82 percent of the total was required in processing sand and gravel; metal mines and mills and nonmetal mines, quarries, and mills each used about 9 percent of the total requirements; processing requirements for coal were less than 1 percent of the total.

Recirculating procedures accounted for 1.17 billion gallons (13 percent) of total water requirements, and new makeup water totaled about 7.89 billion gallons (87 percent). Approximately 95 percent (7.48 billion gallons) of the new makeup water was returned to the source; only 412 million gallons (less than 5 percent of new makeup water) was consumed in the product or evaporated during processing.

Nonmetal mining and milling operations (excluding sand and gravel operations) utilized extensive water recirculating techniques; approximately 97 percent of the water requirements in nonmetal mining and milling were from recirculated water.

TABLE 6.—Water use by the mineral industry in 1962

(Million gallons)

Industry	New water	Recirculated water	Total water use	Water discharged	Water consumed	Water usage in petroleum
Metal mines and mills	821	17	838	779	42	----------
Nonmetal mines and mills	23	664	687	22	1	----------
Quarries and mills	91	----------	91	86	5	----------
Sand and gravel mines and processing plants	6,944	469	7,413	6,582	361	----------
Coal, bituminous	17	25	42	15	3	----------
Petroleum and natural gas	----------	----------	----------	----------	----------	3
Total	7,896	1,175	9,071	7,484	412	3

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasives.—Manufacturers Mineral Co., Chewelah, Stevens County, produced a small quantity of silica grinding pebbles for use at its Seattle plant. The Carborundum Co., Vancouver, manufactured silicon carbide in electric-resistance furnaces for abrasives, chemical, and refractory purposes from a charge containing silica (quartz and sand), petroleum coke, sawdust, and salt. Crude silicon carbide was hand-slabed with pneumatic hammers and crushed to various sized fractions. Some abrasive-grade material was processed for use in sand-blasting; the greater portion of abrasive-grade crude silicon carbide was shipped to abrasive-grain sizing and treatment plants in the Eastern United States for further processing into material suitable for use in bonded and coated abrasive products. Chemical-grade material was made into briquets at Vancouver and shipped to the steel and foundry industries for use as a furnace additive. Refractory-grade silicon carbide was shipped to the company Perth Amboy, N.J., refractory plant.

Cement.—Combined output of portland and masonry cement remained substantially the same as in 1962; shipments were 2 percent greater than in 1962. Production from six plants, operated by four companies, was about 67 percent of capacity (63 percent in 1962). Yearend stocks increased slightly.

Shipments of portland and masonry cement terminated mainly within the State (96 percent); out-of-State shipments were made to Idaho, Montana, Oregon, and Alaska. Of the total portland cement shipped 79 percent was transported by truck, 20 percent by rail, and 1 percent by boat. The ratio of bulk to container (paper bag) shipments was about 6:1.

Combined production from nine cement plants in Oregon and Washington was 7,798,816 barrels (376 pounds each) of finished portland cement; the same plants shipped 7,727,348 barrels of portland cement. The average value of portland cement shipped by Oregon and Washington producers was $3.57 per barrel, f.o.b. plant.

Clays.—The quantity of clays sold or used by producers advanced 45 percent, mostly because of increased output of miscellaneous clay for heavy clay products (building brick and draintile) and a marked increase of fire-clay output for use in refractory products.

Fire clay was mined in King and Spokane Counties. Miscellaneous clay for making heavy clay products was furnished from 13 pits in 8 counties. King, Spokane, and Whatcom Counties with one pit each, were the sources of clay used in manufacturing cement. A small quantity of bentonite, used for lining irrigation canals, was dug in Yakima County.

Diatomite.—Production of diatomite declined 6 percent from the 1962 total. Kenite Corp., the sole producer, continued to mine and process diatomite at its Quincy operation, Grant County. Prepared diatomite was marketed for filler, insulation, and miscellaneous purposes. Plant improvement included installation of a calcining system.

Gypsum.—No gypsum was produced; however, Agro Minerals, Inc., sold gypsum for agricultural purposes from stockpiles of material mined previous in Okanogan County.

Crude gypsum, imported from Baja California, Mexico, was prepared for use in building products by Kaiser Gypsum Co., Inc., Seattle. A Spokane firm, Greenacres Gypsum Co., Inc., marketed gypsum imported from Canada for agricultural purposes.

Lime.—Production of lime was more than double the 1962 total. Increased output was largely due to initial operation of the Pacific Lime, Inc., lime plant at Tacoma, which has a capacity of 250 tons per day. Limestone from company quarries at Texada Island, British Columbia, was shipped to the plant by barge. Quicklime and hydrated lime were marketed for use in water and sewage treatment and for use by the pulp and paper, iron and steel, construction, agricultural, glass, and tanning industries. The Pacific Lime, Inc., Tacoma operation was the subject of a report.[4]

Limestone was calcined to lime for captive use in sugar refining at Utah-Idaho Sugar Co. refineries in Grant and Yakima Counties.

Calcium carbonate sludge was reclaimed and calcined to lime at eight pulpmills for use in paper manufacturing.

Magnesian Minerals.—Increased demand for refractory magnesia by the steel industry resulted in a 28-percent increase in tonnage and value of crude magnesite mined by Northwest Magnesite Co.

Olivine output, processed to various sized fractions and marketed principally for use as foundry sand to consumers in the Western and Midwestern States and Canada, continued to increase; processed-olivine sales were 44 percent greater than the 1962 total. Crude material was mined by Northwest Olivine Co., Pacific Olivine, and Scheel Stone Co., in Skagit County, and by Olivine Corp., Whatcom County. Omega Mining, Inc., Skagit County, shipped crude olivine from stockpiled material to Clear Lake for processing. Olivine was processed by crushing and screening into sized fractions by Northwest Olivine Co., Hamilton, and Northwest Talc & Magnesium Co., Clear Lake. Olivine Corp. announced plans to install milling equipment at Bellingham. Experience with the use of olivine as a molding, facing, coremaking, and refractory sand at a Pacific Northwest foundry was the subject of a report.[5] The massive Twin Sisters olivine-chromite-bearing zone was described in a report.[6]

Agro Minerals, Inc., recovered epsomite (hydrous magnesium sulfate) for use as a fertilizer ingredient from the Poison Lake deposit, Okanogan County.

Pumice.—Completion of construction work at the Wanapum Dam reduced demand for pumicite, which was used as a pozzolan material. The Grimes Co. pozzolanic-pumice-producing plant, which supplied the dam project, was dismantled. Ewer Lumber Co., Omak, the only producer, marketed pumice for use as concrete aggregate.

---

[4] Rock Products. Western Lime Plant Features Thermal Efficiency. V. 66, No. 7, July 1963, pp. 51–54.

[5] Gould, Herbert E. Olivine in the Ferrous Foundry. Foundry, v. 91, No. 10, October 1963, pp. 84–89.

[6] Ragan, Donal M. Emplacement of the Twin Sisters Dunite, Washington. Am. J. Sci., v. 261, June 1963, pp. 549–565.

Sand and Gravel.—Output of sand and gravel was 22.8 million tons valued at $20.5 million, compared with 19.6 million tons valued at $18.1 million in 1962. The rise was due largely to increased requirements by the U.S. Army Corps of Engineers in dam construction activities.

Sand and gravel output by commercial firms operating 147 plants was 12.4 million tons, and Government-and-contractor production was 10.4 million tons, compared with 12.8 and 6.8 million tons, respectively, in 1962.

Sand and gravel was produced in 35 of the 39 counties. Output was valued at over $3 million in both Pierce and Walla Walla Counties, over $2 million in King County, and more than $1 million each in Columbia, Snohomish, Spokane, and Yakima Counties.

TABLE 7.—Sand and gravel sold or used by producers, by classes of operation and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	4,699	$5,373	5,794	$6,504
Road material	5,338	5,167	3,491	3,431
Fill	1,542	723	2,033	1,324
Railroad ballast	375	263	468	446
Other [1]	832	1,102	612	780
Total	12,786	12,628	12,399	12,485
Government-and-contractor operations:				
Building	171	228		
Road material	5,149	4,504	7,773	6,428
Fill	1,361	683	2,546	1,530
Other [1]	113	102	43	47
Total	6,794	5,517	10,362	8,005
All operations:				
Building	4,870	5,601	5,794	6,504
Road material	10,487	9,672	11,264	9,859
Fill	2,903	1,406	4,578	2,854
Railroad ballast	375	263	468	446
Other [1]	945	1,203	656	827
Total [2]	19,580	18,145	22,760	20,490

[1] Includes special sands for construction and industrial uses and sand and gravel for miscellaneous unspecified purposes.
[2] Owing to rounding, individual items may not add to totals shown.

Distribution by use was roadbuilding and maintenance, 50 percent; construction, 25 percent; fill, 20 percent; railroad ballast, 2 percent; and miscellaneous, 3 percent. Included under miscellaneous were small but important quantities of special industrial silicia-bearing sands utilized for glass manufacturing, grinding, polishing, sandblasting, and foundry applications.

Stone.—Stone was quarried in 37 of the 39 counties; output totaled 12.9 million tons valued at $16.3 million, compared with 12.7 million tons valued at $18.2 million in 1962.

Increased output was largely the result of State and county road construction projects; decreased value resulted from diminished de-

mand for stone by the U.S. Army Corps of Engineers for use in railroad and dam embankment and cofferdam construction.

Basalt, accounting for 10.6 million tons of the total stone output, was used for concrete aggregate, roadstone, riprap, and ballast.

Dimension stone was produced in Ferry (sandstone, marble), Kittitas (sandstone), Pierce (sandstone), Skagit (sandstone), Spokane (granite), and Stevens (marble and limestone) Counties.

TABLE 8.—Stone sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1962		1963	
	Quantity	Value	Quantity	Value
Dimension stone (building)	15	$403	77	$323
Concrete and roadstone	8,554	9,940	8,948	10,271
Riprap	2,614	4,656	2,439	2,799
Railroad ballast	169	233	(1)	(1)
Other [2]	1,397	2,948	1,471	2,954
Total [3]	12,749	18,180	12,934	16,346

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Used at cement, paper, metallurgical, and chemical plants, at sugar refineries, and for miscellaneous unspecified purposes, also includes items indicated by footnote 1.
[3] Owing to rounding, individual items may not add to totals shown.

Crushed granite from Chelan, Douglas, King, Kittitas, Okanogan, and Spokane Counties was used as riprap, roadstone, and poultry grit.

Limestone output from Chelan, Pend Oreille, Skagit, Stevens, and Whatcom Counties was used in manufacturing cement. Crushed limestone for agricultural purposes came from Snohomish and Stevens Counties. Limestone products for use in paper manufacturing were made in Stevens and San Juan Counties, and Stevens County was the source of metallurgical-grade limestone.

Crushed-marble products from Stevens County quarrying operations were marketed for agricultural purposes, terrazzo chips, and roofing granules, and as marble whiting for fertilizer filler.

Sandstone, quartz, and quartzite for use as industrial silica were produced in Pend Oreille, Skagit, Spokane, and Stevens Counties. Output was used by the cement, glass, metallurgical, and chemical industries.

Talc and Soapstone.—Tonnage of soapstone output increased 5 percent, compared with the 1962 total. Soapstone mining was limited to Skagit County, where two operators near Marblemount produced raw material for grinding at plants of Northwest Talc & Magnesium Co. (Clear Lake), Miller Products Co., and Stauffer Chemical Co. (both in Portland, Oreg.). Ground material was used in insecticides and for paint manufacture. A third operator near Marblemount mined and marketed a small quantity of talc for sculpturing purposes.

Vermiculite.—Crude vermiculite produced in Montana was exfoliated at the Vermiculite Northwest, Inc., Spokane plant. Output of the expanded product, slightly less than in 1962, was marketed for use in insulation and lightweight-plaster and concrete aggregates.

METALS

Aluminum.—Production of primary aluminum, the highest in 6 years, climbed from 371,757 tons valued at $178.2 million in 1962 to 439,144 tons valued at $202.3 million. By midyear, Washington producers were operating at capacity (except the Kaiser Aluminum & Chemical Corp. idle Tacoma plant) for the first time since 1957.

The reactivation of two potlines, one each at Vancouver and Wenatchee, placed Aluminum Company of America operations at full capacity. Also, at the Vancouver plant a third extrusion press and additional alloy-ingot-casting equipment were installed and placed in operation.

The Mead plant of Kaiser Aluminum & Chemical Corp. operated at capacity with the restart of the eighth potline in May. Kaiser's improvement and expansion program included 6 new remelting furnaces with a capacity equivalent to that of 24 of the old models, new modern facilities for heat treating larger quantities of aluminum sheet, and additional extrusion-billet-producing capacity at the Mead south plant of Kaiser (formerly a Government-owned magnesium plant).

TABLE 9.—Primary aluminum plant capacity and production data

Year	Rated primary capacity, short tons	Primary production			Average U.S. ingot price per pound, cents
		Short tons	Percent of national total	Value (thousands)	
1954–58 (average)	463,000	425,748	27	$198,113	25.2
1959	483,000	333,615	17	165,423	26.9
1960	483,000	346,126	17	181,138	[1] 26.0
1961	483,000	331,264	17	168,921	25.5
1962	483,000	371,757	18	178,226	23.9
1963	483,000	439,144	19	202,327	22.6

[1] Price of pig now applied to ingot. The use of the term "pig" was discontinued in August 1960.

Aluminum fabrication in the Pacific Northwest was described in a Bureau of Mines report.[7]

Copper.—Copper output was less than in 1962. Most of the metal was recovered as a byproduct of lead-zinc mining in Pend Oreille County. Small quantities were obtained from two copper mines—Borderline No. 6 (Stuart Mayo, Okanogan County) and Lucky Joe (Lucky Joe Mining Co., Pend Oreille County).

Because of competition for copper ores and concentrates in the free world markets, American Smelting and Refining Company continued to operate its Tacoma plant at only one-half of the rated annual capacity of 103,000 tons of refined copper.

Ferroalloys.—Ferrosilicon and silicon metal were produced by Ohio Ferro-Alloys Corp., Tacoma, and Keokuk Electro-Metals Co., Wenatchee.

Gold.—Gold output increased 5 percent over that of 1962. As in 1962, Knob Hill Mines, Inc. (Gold Dollar and Knob Hill mines),

[7] Fulkerson, Frank B. Aluminum Fabrication in the Pacific Northwest: An Economic Survey. BuMines Inf. Circ. 8123, 1962. 29 pp.

Ferry County, and L–D Mines (Gold King mine), Chelan County, were the principal gold-producing companies in the State. The only other mining company with lode-gold production was Wind River Mining Co. (Wind River mine), Skamania County, which produced 232 ounces. A few ounces of gold was produced from small-scale placering. Placer gold was recovered by Golden Thunderbird Mining Co., Inc., in the Swauk-Liberty district, Kittitas County, but the quan-

TABLE 10.—Mine production of gold, silver, copper, lead, and zinc in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1954–58 (average)	21	2	1,486	[3]	[3]	[3]	[3]
1959	15	1	958	[3]	[3]	[3]	[3]
1960	17	----------	1,070	[3]	[3]	[3]	[3]
1961	15	3	1,103	[3]	[3]	[3]	[3]
1962	20	2	958	[3]	[3]	[3]	[3]
1963	11	2	985	[3]	[3]	[3]	[3]
1860–1963	----------	----------	[4]	[5] 2,844,331	[5] $78,307	[5] 16,391	[5] $12,333

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1954–58 (average)	2,454	$1,727	10,738	$3,043	24,049	$5,701	$13,776
1959	49	30	10,310	2,371	17,111	3,936	10,986
1960	78	50	7,725	1,808	21,317	5,500	12,388
1961	66	40	8,053	1,659	20,217	4,650	10,986
1962	41	25	6,033	1,110	21,644	4,978	9,733
1963	[3]	[3]	5,374	1,161	22,270	5,122	10,168
1860–1963	[6] 121,855	[6] 43,297	227,014	51,842	483,682	109,473	325,104

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, and ore shipped to smelters during calendar year indicated. Because of rounding, individual items may not add to totals shown.
[2] Does not include gravel washed.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] 1860–1903 data not available; 1904–63, 33,384,700 short tons.
[5] Excludes 1957–63.
[6] Excludes 1963.

TABLE 11.—Mine production of gold, silver, copper, lead, and zinc in 1963, by classes of ore or other source material, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold and gold-silver [2]	4	174,543	[3]	[3]	[3]	1,000	----------
Copper	2	24	[3]	[3]	[3]	----------	----------
Lead-zinc	5	810,284	[3]	[3]	[3]	10,747,000	44,540,000
Total	11	984,851	[3]	[3]	[3]	10,748,000	44,540,000
Placer operations	2	[4]	[3]	[3]	----------	----------	----------
Grand total	13	984,851	[3]	[3]	[3]	10,748,000	44,540,000

[1] Detail will not necessarily add to total, because some mines produce more than 1 class of material.
[2] Combined to avoid disclosing individual company confidential data.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] 460 cubic yards gravel washed.

tity and value was not included in production totals because the gold was not sold during the year.

Iron and Steel.—Three firms—Bethlehem Steel Co., Seattle, King County; Star Iron and Steel, Tacoma, Pierce County; and Union Iron Works, Spokane, Spokane County—announced expansion programs in the structural steel field.

Lead.—Lead output, lowest in 16 years, totaled 5,374 tons and was worth $1.2 million, compared with 6.033 tons and $1.1 million in 1962. The increased value from lower production was caused by a higher average market price of 10.8 cents per pound in 1963, compared with 9.2 cents per pound in 1962. Four mines in Pend Oreille County—American Zinc, Lead & Smelting Co., Grandview and Mineral Right mines; Pend Oreille Mines & Metals Co., Pend Oreille mine; and Cowie & Shoemaker, Jim Creek mine—yielded all but 1 ton of the total production. Three other companies accounted for the remaining ton.

Magnesium.—Two companies announced plans to build magnesium reduction plants in the State. Harvey Aluminum, Inc., Torrance, Calif., was to use sea water as a raw material for its 20,000-ton-annual-capacity plant at Port Angeles, while Standard Magnesium Corp., Tulsa, Okla., was to use byproduct magnesium chloride from Utah for its 11,000-ton-annual-capacity plant at Vancouver.

Silver.—Output of silver came largely from the Knob Hill and Gold Dollar properties in Ferry County. The Pend Oreille mine in Pend Oreille County and the Gold King mine in Chelan County contributed considerably smaller but still substantial quantities. With an increased yield of 6 percent, value increased 25 percent due to a higher average market price of $1.28 per ounce, compared with $1.09 in 1962.

Three gold producers supplied 90 percent of the total silver output. Silver was recovered at the average rate of 3.4 ounces per ounce of recoverable gold. Five lead-zinc operations furnished 8 percent of the silver output, with an average of 5.6 ounces of silver per ton of lead. One silver and two copper lode producers and one placer operation supplied the remainder.

Uranium.—Uranium ore production (ore milled) increased 6 percent to 117,286 tons, and value increased 24 percent to $2.5 million. Dawn Mining Co. closed the Midnite mine, and by yearend the Ford mill was operating on stockpiled ore. After 6.5 years of operation, yearend (1962) ore reserve estimates were 847,498 tons with an average grade of 0.248 percent uranium oxide. The company's stockpile of about 250,000 tons was more than sufficient to fulfill the Atomic Energy Commission uranium oxide purchase contract which was to expire at the end of 1966.

Zinc.—Output and value, 22,270 tons and $5.1 million, respectively, gained 3 percent over those of 1962. All of the production was from northeastern Washington; most was supplied by two mining firms—American Zinc, Lead & Smelting Co. and Pend Oreille Mines & Metals Co.

MINERAL FUELS

Carbon Dioxide.—Recovery of carbon dioxide from mineral waters in Klickitat County by Gas-Ice Corp. increased 17 percent over the 1962

total. Output was processed and marketed as Dry Ice. Carbon dioxide also was recovered from an ammonia-plant waste product at the company Finley operation in Benton County.

Coal.—Output from six coal mines in four counties was 190,225 tons, a decline of 19 percent from the 1962 tonnage. Kittitas County led in coal production, followed by King, Thurston, and Lewis Counties.

Construction was postponed indefinitely on the long-proposed 500,000-kilowatt coal-fired steam powerplant at the Roslyn-Cle Elum coalfields. An 800,000-kilowatt steamplant that the Washington Public Power Supply System was building at the Atomic Energy Commission Hanford Works reportedly had supplanted the Cle Elum proposal. Upon postponement of this measure, Northern Pacific Railway Co. closed the Roslyn coal mines at yearend because of declining demand for the coal.

The Federal Bureau of Mines continued research in hydraulic mining of bituminous coal at a mine near Roslyn. Coal mining with high-pressure jets of water was started in September at the Roslyn No. 10 mine. The research was conducted under a cooperative grant of $15,000 by the Area Redevelopment Administration. Previously, experiments in mining the steeply dipping coal beds with high-pressure jets of water were performed by the Bureau of Mines in cooperation with Northern Pacific Railway Co. at the company Roslyn No. 9 mine.

Peat.—Shipments of peat totaled 37,248 tons, a decline of 11 percent from the 1962 tonnage. King County led in output, followed by Kitsap, Snohomish, Thurston, and Skagit Counties.

Petroleum and Natural Gas.—Both onshore and offshore exploration activity was underway, with interest primarily on two wells inland (Union Oil Co. of California, No. 1 Wilson Creek and Phillips Petroleum Corp. No. 1 Washington State) and on seismic exploration off Umtilla Reef and off the southwestern Washington coast (Shell Oil Co. et al).

The first leasing by the Federal Government of offshore lands (lying beyond the State 3-mile limit) in the Pacific Northwest was announced in August when the U.S. Department of the Interior called for nominations of areas for prospective oil and gas leasing on the outer Continental Shelf off the coasts of Washington and Oregon. By calling for nominations, the first formal step in leasing procedure, the Department of the Interior requested oil firms to indicate areas of interest. This enabled the Bureau of Land Management to select areas which would be subject to sealed bid. Nominations for Federal offshore tracts were to be submitted to the Director, Bureau of Land Management, by November 1. Sealed bids on specific Federal tracts by oil firms were to be called for by the Department of the Interior by October 1, 1964.

Shell Oil Co. announced plans for modification and expansion of its Anacortes refinery to provide for increased flexibility in handling different quality crude oils. The project, scheduled for completion early in 1964, included installing facilities for handling an additional 350,000 barrels of crude oil and modification of the alkylation plant to boost production capacity of that unit to 2.5 million barrels of alkylate per year.

TABLE 12.—Test holes drilled for oil and gas in 1963

Company	Well	Total depth (feet)	County
Seattle—Hoh Oil Associates	Woodis No. 1	460	Jefferson.
Union Oil Co. of California	Wilson Creek No. 1	4,989	Pacific.
Phillips Petroleum Co	State No. 1	12,920	Pierce.
Washington Water Power Co	W.W.P. No. 1	(1)	Spokane.
Bonanza Oil Corp	Bonanza No. 1	2,840	Stevens.
Bomar Drilling Corp	Dalton No. 1	3,125	Thurston.

[1] Data not available.

Source: Washington Division of Mines and Geology.

At a public hearing in Los Angeles on petroleum imports into District 5 (Washington, Oregon, California, Nevada, and Arizona), both independent and major refiners criticized the flow of Canadian oil into Puget Sound refineries operated by Mobil Oil Co., Shell Oil Co., and Texaco, Inc. The Independent Refiners Association of California, Tidewater Oil Co., Richfield Oil Corp., and Union Oil Co. stated that more severe quota limitations should be placed on importing oil from Canada into District 5. Companies with refineries in the Puget Sound area defended importing the crude oil by stating that Canadian oil was needed to augment heavy inventory withdrawals, and that if the Canadian oil were not given a preferred position, little, if any, would move into this area.

Exploration for an underground natural gas storage reservoir, intended to provide sufficient reserve capacity to service natural gas consumers, was conducted on a 4,000-acre tract 9 miles south of Chehalis by El Paso Natural Gas Co., Washington Water Power Co., and Washington Natural Gas Co. The first phase of the project, which included drilling eight holes to moderate depths of 2,000 to 3,000 feet, was completed in November, and equipment was installed late in the year to allow actual injection of gas to the reservoir. If the injection tests were successful, the potential storage capacity might reach 10 billion cubic feet of gas, making it one of the largest natural gas storage facilities in the country.

A report of particular interest to those concerned with petroleum exploration in the Pacific Northwest was published.[8]

REVIEW BY COUNTIES

Mineral production was reported from all 39 counties. With certain important exceptions, output was principally from nonmetal deposits. Only selected counties with significant metal and nonmetal developments are discussed in the following review.

Chelan.—Ideal Cement Co. mined and shipped limestone from the Soda Springs quarry near Leavenworth to the company Grotto cement plant, King County.

According to Day Mines, Inc., annual report to shareholders, ore reserves of L–D Mines (Gold King mine) decreased substantially

[8] Snavely, Parke D., Jr., and Holly C. Wagner. Tertiary Geologic History of Western Oregon and Washington. Washington Div. of Mines and Geol. Rept. of Inv. 22, 1963, 25 pp.

in 1963 because of the removal of 89,000 tons of ore and the failure of a development program to substantially increase ore reserves. Development work included 4,891 feet of new workings and 13,018 feet of test drilling. A surface gold-silver ore showing discovered about a mile north of the present workings contained better-than-average grade ore.

Clark.—Hidden Brick Co., Vancouver, and Ridgefield Brick & Tile Co., Ridgefield, produced clay for use in making building brick and draintile.

Stone production was the highest for any county in the State; over 1 million tons of basalt was quarried for use as riprap and in road construction.

A $500,000 expansion program was initiated by Alcoa at its Vancouver plant to provide facilities for manufacturing insulated aluminum wire and cable. Earlier in the year, a potline was reacti-

TABLE 13.—Value of mineral production in Washington, by counties

(Thousand dollars)

County	1962	1963	Minerals produced in 1963 in order of value
Adams	$194	$229	Stone, sand and gravel.
Asotin	16	19	Sand and gravel.
Benton	108	179	Stone, sand and gravel.
Chelan	1,043	(1)	Gold, stone, sand and gravel, silver, pumice.
Clallam	242	279	Sand and gravel, stone.
Clark	560	1,206	Stone, sand and gravel, clays.
Columbia	----------	1,435	Sand and gravel, stone.
Cowlitz	158	171	Stone, sand and gravel, clays.
Douglas	217	791	Stone, sand and gravel.
Ferry	(1)	(1)	Gold, silver, stone, copper, lead.
Franklin	874	580	Sand and gravel, stone.
Garfield	102	164	Stone.
Grant	1,687	1,591	Diatomite, stone, lime, sand and gravel.
Grays Harbor	352	338	Sand and gravel, stone.
Island	393	(1)	Stone, sand and gravel.
Jefferson	337	317	Do.
King	11,363	9,418	Cement, sand and gravel, stone, coal, peat, clays.
Kitsap	219	493	Sand and gravel, stone, peat.
Kittitas	1,373	1,020	Coal, sand and gravel, stone.
Klickitat	4,290	742	Stone, sand and gravel, carbon dioxide.
Lewis	618	688	Stone, sand and gravel, coal, clays.
Lincoln	318	122	Sand and gravel.
Mason	15	133	Stone, sand and gravel.
Okanogan	126	175	Stone, sand and gravel, silver, coppe , gold, epsomite, lead.
Pacific	303	387	Stone.
Pend Oreille	(1)	(1)	Zinc, cement, lead, stone, sand and gravel, silver, copper.
Pierce	3,402	4,470	Sand and gravel, lime, stone, clays.
San Juan	5	(1)	Sand and gravel, stone.
Skagit	3,323	3,751	Cement, olivine, stone, sand and gravel, talc and soapstone, peat.
Skamania	341	87	Stone, sand and gravel, gold, silver, copper.
Snohomish	4,106	2,313	Sand and gravel, stone, peat, clays, gold.
Spokane	3,540	3,773	Cement, sand and gravel, stone, clays.
Stevens	3,938	4,364	Uranium, magnesite, stone, sand and gravel, clays, grinding pebbles.
Thurston	469	314	Stone, sand and gravel, coal, peat.
Wahkiakum	116	46	Stone.
Walla Walla	855	4,593	Sand and gravel, stone.
Whatcom	(1)	(1)	Cement, stone, sand and gravel, clays, olivine.
Whitman	437	1,085	Stone, sand and gravel.
Yakima	1,798	1,563	Sand and gravel, lime, stone, clays.
Undistributed [2]	21,236	24,594	
Total	68,474	71,430	

[1] Figure withheld to avoid disclosure of individual company confidential data; included with "Undistributed."

[2] Includes value of mineral production that cannot be assigned to specific counties and values indicated by footnote 1.

vated, and a third extrusion press and additional ingot-casting equipment were installed and placed in operation.

Cowlitz.—Reynolds Metals Co. aluminum-reduction plant at Longview was operated at capacity.

Douglas.—Keokuk Electro-Metals Co. continued to operate its ferrosilicon and silicon metal plant at Wenatchee at about 50 percent of rated capacity. With the reactivation of a potline, Alcoa's Wenatchee aluminum-reduction plant was operated at capacity.

Ferry.—The leading producer of gold and silver in the State, Knob Hill Mines, Inc., operated its Knob Hill mine and the adjacent Gold Dollar mine owned by Day Mines, Inc. According to the Day Mines, Inc., annual report to shareholders, ore reserves of the joint operation at Republic remained about the same as in 1962. The 12th level was extended through the Gold Dollar ore body, which on this level was 600 feet long and of good grade and width but not as rich as at the higher levels.

King.—The county was the principal nonmetal-producing area in the State, in terms of value of mineral commodities.

Production of cement declined slightly at the Ideal Cement Co. Grotto plant, while the Lone Star Cement Corp. Seattle plant was operated at an increased rate.

International Pipe & Ceramics Corp. produced clay from the Blum pit for use as refractory material; the company Palmer, Renton, Preston, and No. 55 pits yielded clay for making clay products, mainly building brick and draintile. Builders Brick Co. operated the Elk and Newcastle clay pits; material was used for manufacturing building brick and draintile. Ideal Cement Co. dug clay at the Gotto pit for use in its cement-making process.

The Rogers No. 2, Rogers No. 3, and Franklin No. 12 mines of Palmer Coking Coal, Inc., supplied the county coal production. The county ranked first as a peat-producing area.

Bethlehem Steel Co. planned to increase substantially its Seattle rolling-mill ability to process both plates and structural shapes, according to an announced $1.4 million expansion program. New hydraulic plate-straightening equipment and related materials-handling equipment were to occupy an additional 20,000 square feet of floor space which was gained by extending two existing buildings.

Bear Creek Mining Co. optioned more than 50 patented mining claims from United Cascade Mining Co. The prospect, located along the Middle Fork of the Snoqualime River, was being mapped, sampled, and diamond-drilled by a 15-man crew.

Kittitas.—Kittitas County retained its position as the leading source of coal. Output was from underground and strip operations by Northern Pacific Railway Co. at the Roslyn No. 9 mine.

Okanogan.—Epsomite was mined by Agro Minerals, Inc., near Tonasket (Poison Lake). A company gypsum operation in the same area was idle.

Silver and copper were recovered from two mines—Fourth of July (Cecil B. Murray, silver) and Borderline No. 6 (Stuart Mayo, copper). One placer operation produced a small amount of gold.

Pend Oreille.—The principal nonmetal producer continued to be the Metaline Falls plant of Lehigh Portland Cement Co. Production by

the company declined 1 percent; however, shipments were 6 percent greater than the 1962 total.

According to the Pend Oreille Mines & Metals Co. annual report to stockholders, 651,922 tons of ore, 5 percent more than in 1962, was mined and milled. The property was not operated at capacity because of a shortage of skilled underground workers. The amount of recoverable metal was 10,007,664 pounds of lead and 33,394,046 pounds of zinc. Operating cost per ton of ore was $3.253, compared with $3.264 the previous year. Underground development consisted of 6,926 feet of drifts and raises, 11,324 cubic feet of station excavation, and 46,974 feet of diamond and long-hole percussion drilling.

TABLE 14.—Production of gold, silver, copper, lead, and zinc in the Metaline district, Pend Oreille County, 1906–63

Year	Material treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)	Total value
1906	26		45		17		$1,973
1907–10							
1911	51	9	1,602	(1)	6	10	2,799
1912–14							
1915	3,111					122	30,368
1916	15,145		85		19	431	118,074
1917	15,093	8	1,504	(1)	65	588	132,717
1918	245		264		92	18	16,917
1919–22							
1923	34		46		16		2,224
1924	966		1,291		434		70,378
1925	914	2	1,043		379		66,675
1926	813	4	1,818	(1)	163	33	32,313
1927	35,348	11	2,913	1	145	468	80,285
1928							
1929	50,920	8	2,250	2	328	1,031	179,592
1930	7,200	9	1,023	(1)	267	352	61,132
1931	80,968	16	4,595	1	1,257	4,974	472,959
1932	33,443	28	2,606	2	682	2,245	177,142
1933	48,479	19	3,263	3	722	3,369	338,365
1934	28,322		1,151	1	237	1,926	184,567
1935							
1936	76,060		3,317	3	770	4,389	512,974
1937	106,028		12,525		2,644	4,095	854,407
1938	249,184		14,584		4,009	11,402	1,473,116
1939	259,320		11,603		3,509	10,130	1,391,570
1940	273,233		8,609		2,495	11,560	1,712,157
1941	361,041		10,807		3,818	14,201	2,573,300
1942	397,630		9,630		4,553	13,620	3,150,270
1943	311,245		7,335		4,581	9,292	2,699,363
1944	305,516		15,580		5,278	9,236	2,961,173
1945	253,884		11,191		3,506	7,794	2,403,559
1946	247,648		7,375	7	2,224	7,685	2,368,098
1947	295,015		10,674	2	3,450	9,754	3,364,749
1948	223,602		9,521		4,297	5,985	3,138,641
1949	243,962		11,396	8	4,030	6,496	2,897,951
1950	417,228		20,432	8	7,445	11,032	5,164,819
1951	510,207	30	22,896	18	5,234	12,753	6,483,614
1952	603,022	22	29,910	28	9,074	14,408	7,746,270
1953	734,967	50	34,574	32	8,694	17,185	6,281,787
1954	595,629	20	22,616	10	8,656	8,863	4,313,221
1955	699,107	9	26,329	26	8,098	11,658	5,324,612
1956	799,447	2	29,360	26	9,439	12,524	6,444,321
1957	985,553		38,821	36	11,971	17,244	7,481,121
1958	839,370	6	34,469	29	8,971	18,796	5,980,258
1959	856,587	1	36,645	28	10,290	17,109	6,352,163
1960	959,822		21,190	41	7,725	21,317	7,352,936
1961	981,646		43,729	38	8,032	20,215	6,367,269
1962	829,655		29,233	35	5,901	21,430	6,067,988
1963	810,280		30,274	35	5,373	22,270	6,342,899
Total	14,546,966	254	590,124	420	168,896	368,010	121,173,086

[1] Less than 0.5 ton.

American Zinc, Lead & Smelting Co. reported to its shareholders that production from the Grandview and Mineral Right mines was substantially reduced below that of 1962. Ore tonnage reduction was 25 percent, and the concentrate reduction was 9 percent. Because proved and indicated ore reserves were less than a year's production, underground development was materially increased with a corresponding decrease in production. Late in the year, the company optioned the Anderson mine, Stevens County, from the Goldfield Corp. (California) and started pumping water from the pit and adit and began a diamond-drilling program. American Zinc, Lead & Smelting Co. became a subsidiary of Consolidated Gold Field of South Africa, Ltd., when the latter firm increased its holdings of the former firm's outstanding stock from 11 to 63 percent.

Pierce.—Pacific Lime, Inc., a subsidiary of Dominion Tar & Chemical Co., began operating a 250-ton-per-day lime plant at Tacoma in February. The grate-kiln system, constructed by the company to supply Pacific Northwest and Canadian customers, was installed to supplant two company lime plants in British Columbia, Canada.

Star Iron and Steel, Tacoma, enlarged and remodeled a building in the port area to provide 100,000 square feet of floorspace to house a modern shop and supporting facilities. The office and engineering staff were to occupy a newly built office building. The firm, in addition to fabricating structural steel, specializes in the design and manufacture of cranes.

Skagit.—The Lone Star Cement Corp. plant at Concrete supplied the major value to the county's mineral industry total. Output increased 24 percent over the 1962 total.

Olivine output from the Twin Sisters quarry by Northwest Olivine Co., the State's largest producer, was trucked to the company Hamilton plant for processing. Output by Pacific Olivine from the Yellow Slide quarry and by Scheel Stone Co. from the Big Slide quarry was shipped to the Northwest Talc & Magnesium Co. custom milling operation at Clear Lake. The Clear Lake mill was revamped by adding air scrubbers, new rolls, and additional screens.

Soapstone was mined near Marblemount by Herman Smith, Skagit Talc Products, and Scheel Stone Co.

Snohomish.—Output of peat dropped considerably, and the county ranked third as a peat-producing area. Reed-sedge peat was produced by Rhod-A-Zalea Gardens, and Joe La Roche Topsoil & Peat Co. dug humus. Lowell Brick & Tile Co. used locally mined clay to make building brick.

Spokane.—The Irvin plant of Ideal Cement Co. continued to be the county's principal nonmetal mineral producer; output declined 4 percent from that of 1962. The company-owned Spokane County clay pit and Stevens County Limerock quarry supplied clay and limestone to the operation.

International Pipe & Ceramics Corp. produced fire clay from the Mica pit; fire-clay refractories and other clay products were made at the company Mica plant. Clay for use in heavy clay products, mainly building brick, was produced at the company Pirello and Adams pits.

Union Iron Works, Spokane, announced that it had leased 60,000 square feet of space in Spokane Industrial Park and would install

three overhead cranes and other equipment for fabricating structural steel.

Stevens.—Northwest Magnesite Co. mining operations at the Red Marble magnesite quarry supplied the largest part of the county nonmetal mineral output value.

Limestone as produced by Ideal Cement Co. (Limerock quarry), International Stone Co. (Madsen No. 2 quarry), Northport Limestone Co. (Sherve quarry), Peter Janni & Sons (Janni quarry), and R. H. Nichols (Wilcox quarry). Output was utilized for manufacturing cement (Limerock quarry); as a metallurgical flux (Janni and Sherve quarries); by the paper industry, for agricultural purposes, and in making stucco (Janni quarry); and for exterior building purposes (Wilcox and Madsen No. 2 quarries).

Marble was produced by Manufacturers Mineral Co. (Cottman Black, June Echo Copper, and Chewelah Yellow quarries), Natural Stone Co. (Sunlite White quarry), North American Nonmetallics, Inc. (Na-No-Me quarries), and W. A. Madsen (Madsen quarry). Output was used for exterior building purposes (Madsen, Sunlite White, and Na-No-Me quarries), marble whiting (Na-No-Me quarries), terrazzo chips and roofing granules (Chewelah Yellow, Cottman Black, June Echo Copper, Madsen, and Na-No-Me quarries), and stucco (June Echo Copper and Na-No-Me quarries).

Silica-bearing materials were produced by Lane Mountain Silica, Inc. (for glassmaking, foundry and chemical purposes, and sandblasting), and Manufacturers Mineral Co. (for foundry and refractory applications).

Diamond drilling by American Zinc, Lead & Smelting Co. confirmed the reported mineral content of the optioned Anderson mine. This mine and the Deep Creek mine were optioned from Goldfield Corp. (California) on a 1-year prospect and explore lease. Near yearend, The Bunker Hill Co. began exploratory drilling on the previously optioned Bonanza property, 12 miles north of Colville. Uranium ore production in the State was ended when the last remaining mine (Midnite) was closed.

Whatcom.—The county ranked second in value for output of nonmetal mineral commodities. The Permanente Cement Co. plant at Bellingham continued to be the principal mineral industry and was the largest cement producer in the State. Limestone for the plant was from the company Kendall quarry near Maple Falls.

A new olivine producer, Olivine Corp., announced plans to install olivine-processing equipment at Bellingham.

Yakima.—West Brothers Construction Co. dug bentonite from the Tietonite pit near Naches for use in sealing irrigation canals.

The Mineral Industry of West Virginia

By James R. Kerr [1]

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the West Virginia Geological and Economic Survey for collecting information on all minerals except fuels.

ALL the major markets for the State's bituminous coal industry increased in 1963 resulting in a $56.5 million increase in value of coal production, the prime factor in the overall 7-percent increase in value of West Virginia's mineral production. Output of the other fuels, including petroleum, natural gas, and natural gas liquids, decreased from that of 1962. Slackened demand for building and paving aggregates was reflected in lower production of sand and gravel and crushed limestone. Increased quantities of crushed and broken sandstone were produced, but this production was to meet the special requirements of a rock-fill dam construction project in Grant County. The clay and lime industries continued to decline, mainly because of continuing poor demand for clay refractories and dead-burned dolomite.

McDowell, Logan, Wyoming, Marion, Kanawha, Raleigh, Monongalia, Boone, and Nicholas, all large coal-producing counties, led in value of production, each with output valued in excess of $30 million.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

Water.—Almost 82 billion gallons of water were used by West Virginia's mineral industries, 60 percent of which was used by the bituminous coal industry at 152 coal preparation plants. In addition, 22 billion gallons of water were used by the State's natural gas liquids processing plants, chiefly for cooling and condensing purposes. Washing and wet screening at sand and gravel plants also required significant quantities of water. Recirculated water provided 85 percent of the requirements for the bituminous coal industry and 69 percent of the needs at natural gas liquids plants. Because of the high recirculation ratios by these two industries, the factor on new water requirements per dollar value of production in West Virginia was significantly lower than in some of its adjoining States.

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

TABLE 1.—Mineral production in West Virginia [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	447	$2,086	414	$2,044
Coal (bituminous) do	118,499	578,293	132,568	634,794
Natural gas million cubic feet	210,698	57,942	210,223	55,919
Natural gas liquids:				
Natural gasoline thousand gallons	32,921	2,216	(2)	(2)
LP gases do	344,969	17,475	(2)	(2)
Petroleum (crude) thousand 42-gallon barrels	3,470	13,880	[3] 3,243	[3] 12,940
Salt thousand short tons	1,042	4,635	(2)	(2)
Sand and gravel do	5,202	10,942	4,808	10,578
Stone [4] do	7,506	13,242	9,452	14,489
Value of items that cannot be disclosed: Calcium-magnesium chloride, cement, dimension sandstone, gem stones, lime, natural gas liquids (1963) and salt (1963)		14,753		37,051
Total		[5] 715,464		767,815

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Included with "Value of items that cannot be disclosed."
[3] Preliminary figure.
[4] Excludes certain stone, included with "Value of items that cannot be disclosed."
[5] Revised figure.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$833,291	1958	$755,020
1953	792,695	1959	760,305
1954	685,020	1960	754,470
1955	767,348	1961	731,163
1956	959,827	1962	770,349
1957	953,524	1963	828,329

TABLE 3.—Water use in the mineral industry in 1962

(Million gallons)

	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	900	13	913	822	78	67.30
Coal, bituminous	7,169	42,024	49,193	5,141	2,028	17.48
Nonmetal mines and mills	1,736		1,736		1,736	260.91
Sand and gravel plants	3,816	3,845	7,661	3,669	147	348.78
Natural gas liquids plants	6,842	15,485	22,327	6,083	759	347.47
Total	20,463	61,367	81,830	15,715	4,748	44.41

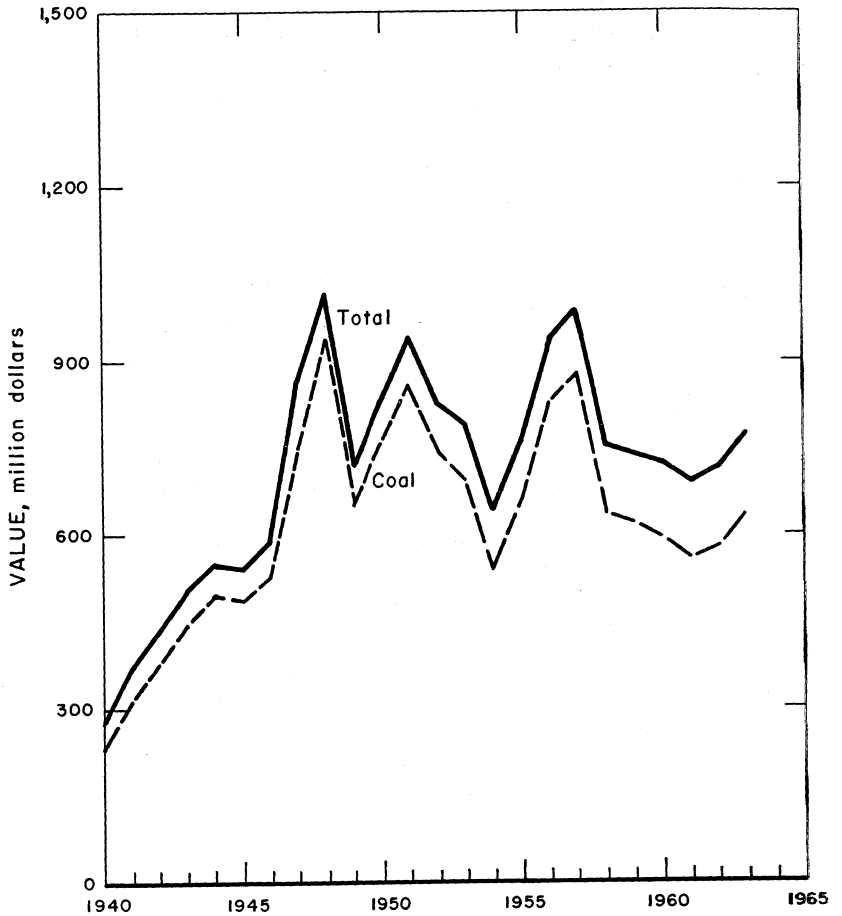


FIGURE 1.—Value of coal, and total value of mineral production in West Virginia, 1940–63.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Responding to increased demand by the electric utility, steel, and export markets, production of coal increased 12 percent to the highest level since 1957. Captive coal production increased 21 percent and sales increased 11 percent. The average value declined for the 6th consecutive year to $4.79 per ton; decreased value combined with lower freight rates made coal more attractive to industrial fuel buyers.

Of total production 91 percent was mined at 1,624 underground mines, 6 percent at 131 strip mines, and 3 percent at 85 auger mines. There was an increase of 157 underground mines in operation, but 4 fewer strip and 19 fewer auger mines were active in 1963.

Of the underground production, 92 percent was mechanically loaded. Tonnage produced by continuous mining increased 23 percent to 47 million tons, which comprised 42 percent of the mechanically loaded output. Sixty-four new continuous miners began operating bringing the total to 445. Mobile loading machines, however, continued to be the most common mechanical loading device with 929 machines in use, an increase of 82 over the number in 1962. Output from these machines rose to 62.4 million tons, or 56 percent of the mechanically loaded output. Of the 445 continuous miners in operation, 151 loaded onto conveyors and 294 into shuttle cars. Of the 929 mobile loaders in use, 815 loaded into shuttle cars, 76 into mine cars, and 38 onto conveyors. In addition, 133 mobile loaders were used behind the continuous miners, loading the mined coal from the bottom. The remainder of the mechanically loaded tonnage was loaded onto 229 hand-loaded face conveyors, 17 fewer than in 1962.

Other equipment used at underground mines included 1,697 cutting machines, 2,346 hand-held or post-mounted drills, 215 mobile drills, and 753 rotary and 396 percussion roof-bolting and rock drills.

Equipment used at strip mines included 259 power shovels, 13 draglines, 11 carryall scrapers, 236 bulldozers, 60 horizontal and 65 vertical overburden drills, and 480 trucks that averaged 16 tons in capacity and 7 miles travel from pit to tipple. Equipment at auger mines included 99 augers, 11 power shovels, 78 bulldozers, 3 horizontal overburden drills, and 208 trucks that averaged 17 tons in capacity and traveled 7 miles from pit to tipple.

For the 3d successive year there was no change in the number of cleaning plants, and output that was mechanically cleaned at 152 plants remained at 75 percent of the total. Of the total cleaned, 34 percent was by jigs, 58 percent by wet washing other than jigs, and 8 percent was by pneumatic methods. Thirty percent of total output was crushed. Fourteen percent of the total output was treated in the following ways: 90 percent with oil, 8 percent with combinations of calcium chloride and oil, 2 percent with calcium chloride, and less than 1 percent with other materials.

According to preliminary data, there were 123 fatal and 4,220 nonfatal lost-time injuries in the State's coal mines in 1963, an increase of 49 in fatalities but a decrease of 135 in nonfatal injuries, compared with 1962. Injury rates were 1.67 fatal and 56.80 nonfatal injuries per million manhours (1.13 and 65.78, respectively, in 1962). Total man-hours increased to 74,290,000 from 66,210,000, and the average number of workers increased from 42,400 to 43,300. Average number of days worked increased from 197.8 to 217.4. Productivity remained at virtually the same rate as in 1962, approximately 14.0 tons per man-shift.

On April 25 an explosion at the Compass No. 2 mine of Clinchfield Coal Co. near Clarksburg in Harrison County took the lives of 22 men. In addition, 101 other fatalities occurred in the State's coal mines in 1963. At underground mines, 53 men were killed by falls of roof or face, 22 by haulage equipment, 2 by explosives, 1 by electricity, 10 by machinery, 1 by mine fire and 1 by miscellaneous causes. At surface installations at underground mines, two men were killed by machinery, one by haulage equipment and two by miscellaneous

causes. At strip mines, three men were killed by machinery and two by miscellaneous causes; and at auger mines one man lost his life in a machinery accident.

The unit-train concept of high-speed, low-cost transportation of coal direct from mines to consumers received impetus as several railroads cut rail rates as much as $1.50 per ton from northern West Virginia to east coast utility markets. These reduced rates were in effect for shipments of 7,000 tons or more to a single destination.

The Office of Coal Research, U.S. Department of the Interior, signed a contract with Consolidation Coal Co. for the construction of a pilot plant at Cresap, W. Va., to manufacture gasoline from coal.

Eastern Associates Coal Co. signed a long-term contract to export coal to a Canadian utility from its Federal No. 1 mine at Grant Town, W. Va., in Marion County. This mine had been closed from late 1962 to September 1963 because of a bad underground mine fire. The reopening of the mine was speeded through the first known use of rock wool insulation pumped from the surface through bore holes to form temporary fire seals until permanent seals could be erected. Closed circuit television also was used for remote photography of the fire area from cameras lowered through bore holes.

Constuction was underway by Virginia Electric and Power Co. for a mine-mouth power station near the Stony River in Grant County near Mt. Storm. Anticipated annual coal requirements are 3 million tons. Output of the 1-million-kilowatt plant will be transmitted through extra-high-voltage transmission lines to the company's major load centers in Virginia.

Coke and Coal Chemicals.—Three oven-coke plants of 668 ovens produced 3.0 million tons of coke valued at $50 million in 1963, a tonnage increase of 15 percent over that of 1962. Average value dropped $0.21 to $16.62 per ton. A small quantity of beehive coke also was produced. Most of the coke was consumed in blast furnaces.

At the oven-coke plants, 4.5 million tons of coal was carbonized; yield of coke from coal was 67.57 percent. Of the coal carbonized, 3.4 million tons was shipped from Pennsylvania, 1 million tons from West Virginia, plus a small tonnage from Kentucky. Most of the coal was high-volatile (84 percent); the balance was low-volatile. Recovered byproducts at the oven-coke plants included 215,000 tons of coke breeze, 49.9 billion cubic feet of coke oven gas, 41,772 tons of ammonium sulfate equivalent, 45.0 million gallons of coke-oven tar and 13.9 million gallons of crude light oil from which was derived benzene, toluene, xylene, and solvent naphtha.

Petroleum and Natural Gas.—Production of petroleum decreased 7 percent. Production was reported curtailed somewhat by a number of factors including proration, lack of pipe lines, limited storage facilities and refineries. Average value per barrel remained at virtually the same rate as in 1962. Natural gas production was slightly less, and average value of production was 3 percent less than in 1962.

Total number of oil and gas wells drilled in 1963 was 1,419, a decrease of 138 from the record high of 1,557 drilled in 1962 (revised figure). Of the wells completed, 782 were gas, 93 oil, 242 oil and gas; 94 storage and pressure, 166 dry holes, and 432 not specified. Depth of wells ranged from 60 to 14,594 feet. Total footage drilled was 3,754,915 feet, an increase of 10 percent over that of 1962 even though

fewer wells were drilled. Average depth per well increased to 2,646 from 2,184 in 1962.

Total initial daily flow of the gas wells was 1,493,863 thousand cubic feet, and the total daily initial flow of oil was 12,836 barrels.

Approximately 90 percent of the total wells drilled were fractured in 1963. Tremendous increases in total initial flow were reported; one exceptional case showed an increase from 8 thousand cubic feet to 39 million cubic feet. Many wells would have been abandoned as dry holes except for fracturing. The West Virginia University collects information concerning fracturing of wells and issues an annual report showing details for each fractured well.

The average size of gas wells was 1,665 thousand cubic feet per day, and the average size of oil wells was 60 barrels per day.

TABLE 4.—Coal (bituminous) production by counties

(Thousand short tons and thousand dollars)

County	1962		1963	
	Quantity	Value	Quantity	Value
Barbour	3,054	$13,190	2,974	$12,137
Boone	5,934	26,941	7,419	32,480
Brooke	734	2,647	867	2,997
Fayette	4,796	22,333	5,397	24,253
Gilmer	1,025	4,336	1,112	4,611
Grant	83	278	62	208
Greenbrier	454	1,954	627	2,385
Harrison	6,472	27,175	7,125	29,241
Kanawha	10,584	44,174	11,213	44,518
Lewis	296	981	(1)	(1)
Lincoln	33	73	12	28
Logan	15,527	67,547	16,275	71,897
McDowell	13,762	88,288	16,067	99,556
Marion	9,150	48,907	9,119	47,694
Mason	454	1,455	437	1,448
Mercer	959	6,006	1,366	8,131
Mineral	52	232	73	269
Mingo	5,432	26,789	5,638	28,101
Nicholas	5,768	28,636	6,567	31,133
Pocahontas	386	1,407	156	563
Preston	2,998	11,036	3,469	12,236
Putnam	75	371	47	202
Raleigh	6,321	34,778	7,628	40,501
Randolph	720	2,963	1,027	4,442
Taylor	450	1,431	421	1,353
Tucker	45	143	98	304
Upshur	1,176	5,071	785	3,276
Wayne	62	276	69	311
Webster	772	3,359	1,151	4,971
Wyoming	10,234	55,599	12,398	66,503
Undistributed [2]	10,691	49,917	12,969	59,045
Total	118,499	578,293	132,568	634,794

[1] Included with "Undistributed."
[2] Includes data for Braxton, Clay, Marshall, Monongalia, and Ohio Counties, and counties indicated by footnote 1.

TABLE 5.—Coal (bituminous) production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1954–58 (average)	137,473	$705,918	1961	113,070	$558,525
1959	119,692	621,003	1962	118,499	578,293
1960	118,944	597,222	1963	132,568	634,794

The estimated number of producing wells at the end of 1963 was gas 19,111 and oil 13,044. During 1963, 69 gas wells and 50 oil wells were abandoned.

Leading counties in oil and gas well drilling were Lewis, 189; Ritchie, 186; Doddridge, 154; Gilmer, 107; Kanawha, 79; Upshur, 75; and Roane, 74. Preston County had the deepest well, a 14,594-foot dry hole.[2]

In 1963, wells were drilled for storage in Marshall, Putnam, Roane, Tucker, and Upshur Counties. Gas was stored in West Virginia from four other States. Six companies were storing gas in West Virginia in 1963 and total storage capacity was 366.1 billion cubic feet. Kanawha, Preston, Harrison, Doddridge, and Lewis Counties had large underground storage facilities.[3] In a similar study in 1961, 376.9 billion cubic feet of storage facilities were reported.

According to the American Petroleum Institute and the American Gas Association, reserves of petroleum were 57 million barrels, and of natural gas 2,311,000 million cubic feet as of December 31, 1963. The standard conditions of estimating natural gas reserves have been changed from 14.65 pounds per square inch, absolute at 60° F. to 14.73 pounds per square inch, absolute at 60° F.

Natural Gas Liquids.—Production of both natural gasoline and LP gases was slightly less than in 1962. According to the American Gas Association, reserves of natural gas liquids as of December 31, 1963, were 68,779,000 42-gallon barrels. This was an increase of 9,920,000 barrels over that of 1962. Extensions and revisions totaled 11,996,000 barrels, and discoveries of new fields and new pools totaled 5,998,000 barrels.

NONMETALS

Clays.—Production of clays decreased 7 percent to 414,000 tons, the lowest level since 1945 and significantly below the 1.1 million tons produced in 1951. Miscellaneous clay production was almost entirely for building brick and cement manufacture. Fire clay production was mostly for firebrick and block (including ladle brick). There were 12 clay mines in operation, 8 of which were open-pit mines and 4 were underground mines. Hancock County led in fire clay production, and Berkeley County was the leading miscellaneous-clay-producing area.

TABLE 6.—Clays sold or used by producers

Year	Fire clay		Miscellaneous clay		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1954–58 (average)	358,200	$1,959,732	298,082	$262,992	656,282	$2,222,724
1959	328,792	2,178,974	266,932	312,970	595,724	2,491,944
1960	346,053	2,328,865	279,570	310,341	625,623	2,639,206
1961	259,340	1,964,265	215,497	228,531	474,837	2,192,796
1962	242,913	(1)	203,954	(1)	446,867	2,085,597
1963	236,695	(1)	177,624	(1)	414,319	2,044,390

[1] Figure included in total to avoid disclosing individual company confidential data.

[2] Tucker, R. C., Oil and Gas Developments in West Virginia in 1963. Bull. of the Am. Assoc. of Petrol. Geol., v. 48, No. 6, pp. 809–812.

[3] Oil and Gas Journal. V. 62, No. 18, May 4, 1964, p. 98.

Cement.—Shipments of portland cement decreased slightly, but masonry cement shipments increased over 1962 shipments. Average values of both types were lower than in 1962 as prices were cut to retain customers in a highly competitive market. The State's only producer operated a wet-process 6-kiln plant at Martinsburg and reported mining its requirements of cement rock, limestone, and shale. Shipments, mostly the general use, non-air-entrained types, were made mainly in bulk by railroad and truck. Leading consumers were ready-mixed concrete companies, concrete-product manufacturers, building-material dealers and highway contractors in Maryland, Virginia, the District of Columbia, and western Pennsylvania.

A new cement distribution terminal was opened by Marquette Cement Manufacturing Co. on the Kanawha River near Charleston. Cement for the plant will be shipped in 14,000-barrel self-unloading barges from the company's Superior, Ohio, plant.

Gem Stones.—Miscellaneous mineral specimens were collected by hobbyists at scattered locations throughout the State. Specimens collected in recent years included cave onyx, aragonite, stilbite, and fossils.

Lime.—Production of lime decreased again in 1963 to its lowest level since the 1930's. Sales of refractory lime (dead-burned dolomite) dropped in 1963 and were not offset by increased shipments of building lime (masonry mortar) and lime for consumption by the steel industry, mainly in open-hearth furnaces. Only small sales of agricultural lime were reported. Two companies operated three lime plants, two in Berkeley County and one in Jefferson County.

Sand and Gravel.—Production of sand and gravel decreased 8 percent from that in 1962. Major declines were reported in sand use for building, molding, and glass manufacture and in gravel use for building. However, output of paving sand and gravel increased. Building aggregate continued to be the leading market, consuming 46 percent of the total output. Paving sand and gravel and the specialized market for industrial and ground sand comprised most of the remainder. Glass manufacture was an important market for industrial sand. Of total output, 64 percent was sand and 36 percent was gravel. Average value per ton increased by $0.10 to $2.20. No production of Government-and-contractor sand and gravel was reported. Production was reported by 22 operations in 16 counties. Hancock County led in production followed in descending order by Morgan, Tyler, Wood, Ohio, and Brooke Counties. Morgan County, with valuable glass sand deposits, led in value of production. The major portion of the production outside Morgan County was recovered by dredges on the rivers in the State.

Natural Salines.—Calcium-magnesium chloride was recovered from naturally-occurring well brines at an operation near South Charleston. Output was more than double that of 1962.

Salt.—Production of salt decreased slightly in 1963. Value of production dropped significantly, however, because of decreased values assigned to captive salt brine production. As in past years, the major portion of the salt was consumed in brine form for the manufacture of chemicals, chiefly chlorine. The only evaporated salt producer in the State, an operation in Mason County, reported the discontinuance

TABLE 7.—Sand and gravel sold or used by producers, by classes of operations and by uses

Class of operation and use	1962		1963	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Building	1,441,748	$1,834,155	1,155,916	$1,493,259
Paving	654,527	995,956	702,227	1,034,048
Fire or furnace	(1)	(1)	53,737	61,798
Railroad ballast			10,400	14,500
Gravel:				
Building	1,355,338	1,635,596	1,051,989	1,305,307
Paving	492,282	825,688	629,866	1,025,673
Fill	(1)	(1)	27,482	45,872
Other [2]	50,473	88,698	(1)	(1)
Undistributed [3]	1,207,236	5,561,910	1,176,590	5,597,109
Total sand and gravel	5,201,604	10,942,003	4,808,207	10,577,566

[1] Included with "Undistributed."
[2] Includes railroad ballast, fill and miscellaneous gravel.
[3] Includes glass, molding, blast, engine, other industrial, and ground sands, fill and other sands, and items indicated by footnote 1.

of salt making in 1963. Production of brine salt was reported from Marshall (two plants) and Kanawha (one plant). The Kanawha County plant, in addition to local natural-occurring brines, processed brines produced in Tyler and Pleasants Counties which were shipped by barge to South Charleston. Except for Kanawha County, all other active salt mining locations produce brines by dissolving rock salt.

Slag (Iron-Blast-Furnace).—Production of crushed air-cooled blast-furnace slag for sales mainly for aggregate uses continued in 1963. The Weirton plant of Standard Slag Co. received its second consecutive certificate of achievement in safety for working over 100,000 man-hours without a disabling work injury.

Stone.—Output of stone increased 26 percent mainly because of increased production of crushed and broken sandstone to meet the fill requirements in the construction of a rock-fill dam on the Stony River near Mt. Storm in Grant County. In addition to the large tonnage of sandstone for that project, increased quantities of sandstone were needed for concrete aggregate and roadstone.

Limestone production fell 6 percent chiefly because of decreased sales of concrete aggregate and roadstone and open-hearth flux. Increased sales of limestone were reported for agricultural uses, asphalt filler, and dust for coal mines, but decreased quantities were used in manufacturing cement and lime. Government-and-contractor sandstone and limestone production and sale of dimension sandstone were virtually unchanged from 1962. Leading limestone-producing counties were Berkeley, Jefferson, and Greenbrier. Sandstone production was centered in Grant County.

TABLE 8.—Stone sold or used by producers, by uses

Uses	1962		1963	
	Short tons	Value	Short tons	Value
Crushed and broken stone:				
Flux	1,460,279	$2,793,764	(1)	(1)
Concrete and roadstone	3,469,065	5,815,292	3,690,708	$5,985,389
Railroad ballast	521,066	726,479	514,665	678,323
Agriculture	(1)	(1)	140,469	309,763
Other [2]	352,840	857,934	(1)	(1)
Undistributed [3]	1,703,006	3,049,022	5,106,374	7,515,997
Total	7,506,256	13,242,491	9,452,216	14,489,472

[1] Figure withheld to avoid disclosing company confidential data, included with "Undistributed."
[2] Includes limestone for glass, asphalt filler, coal dust, poultry grit, stone sand, and miscellaneous uses.
[3] Includes limestone for cement and lime, riprap, refractory sandstone, and items designated by footnote 1.

METALS

Aluminum.—Kaiser Aluminum & Chemical Corp. added a new five-stand rolling mill for producing light gage, can-stock aluminum sheet at its four-potline primary aluminum plant at Ravenswood.

Ferroalloys.—A wide variety of ferroalloys, mainly ferromanganese, ferrosilicon, ferrochromium silicon, silicomanganese, and ferrochromium were produced at Alloy and Graham. A strike closed down the Alloy plant for a period in July.

Iron and Steel.—National Steel Corp. let a contract for the the world's largest continuous casting machine to produce slabs for rolling into sheet, galvanized steel and tin plate. The new installation, rated at 1.5 million tons of steel per year, will have the capacity to process molten steel from 300-ton ladles. The unit will be added to Weirton Steel Co. Div. plant at Weirton where already in use were three Bessemer converters and 14 open-hearth furnaces including 9 furnaces believed to be among the largest in the world, ranging from 450 to 600 tons capacity.[4] Wheeling Steep Corp. continued the expansion and renovation of its Wheeling and Steubenville (Ohio) plants.

Magnesium Compounds.—Magnesium chloride was recovered as a by-product of zirconium sponge manufactured by The Carborundum Metals Co. at its Parkersburg plant.

Zinc.—Increased activity was reported by Matthiessen & Hegeler Zinc Co. at its vertical-retort zinc smelter at Meadowbrook.

Zirconium.—Carborundum Metals Co. continued to produce zirconium sponge and hafnium sponge at Parkersburg, the hafnium sponge being converted to crystal bar by Foote Mineral Co., Exton, Pa. Corhart Refractories Co. produced zircon refractories at Buckhannon.

REVIEW BY COUNTIES

Barbour.—Production of strip-mined coal increased sharply as six new strip pits were put into operation, but output at underground and auger mines decreased causing a 3-percent drop in total production in 1963. Of total output, 68 percent was mined at 31 underground mines, 30 percent at 14 strip mines and 2 percent at 2 auger mines. Grafton

[4] American Metal Market. V. 70, No. 95, May 17, 1963, p. 4.

Coal Co. closed its strip and auger mines. LaRosa Fuel Co., Inc., the leading strip producer, opened a new strip mine. The county was third ranked in strip production. Equipment used at strip mines included 28 power shovels, 2 draglines, 31 bulldozers, 3 carryall scrapers, and 83 trucks which averaged 14 tons in capacity. Of the underground production, 89 percent was mechanically loaded, 63 percent of which was loaded by 21 mobile loaders (5 less than in 1962), and 37 percent by 10 continuous miners (2 more than in 1962). Three cleaning plants, one plant less than in 1962, washed 44 percent of total output; Gage Coal Co. closed its heavy media plant in 1963. Of total output, 82 percent was crushed and 5 percent was treated. Clinchfield Coal Co. closed all three of its mines in the county during 1963 and idled approximately 120 men. Leading producers were Clinchfield Coal Co., Badger Coal Co., Inc., and Bethlehem Mines Corp.

Decreased demand for crushed sandstone aggregate caused the closing of Feather Construction Corp.'s quarry near Belington in May.

Berkeley.—Portland and masonry cements were produced at Martinsburg by Standard Lime & Cement Co., Division of Martin-Marietta Corp., the only cement producer in the State. Output which was used mainly in ready-mixed concrete plants was shipped chiefly to Maryland, Virginia, the District of Columbia, and western Pennsylvania.

The county continued to rank first in limestone production. Producers were Standard Lime & Cement Co.; Blair Limestone Division, Jones & Laughlin Steel Corp.; Fry Coal & Stone Co., Division of Martin-Marietta Corp., all of Martinsburg; and Inwood Quarry, Inc. (formerly J. A. Prather), Inwood. Over half of the limestone production was used in cement and lime manufacture. Other important uses included blast- and open-hearth furnace flux. Both Jones & Laughlin Steel Corp. and Standard Lime & Cement Co. received certificates of achievement in safety for operating their quarries in 1963 without disabling work injuries.

Standard Lime & Cement Co. and Jones & Laughlin Steel Corp. produced mostly quicklime for use by the steel industry.

Clay producers were The United Clay Products Co., North Mountain, and Continental Clay Products Co. and Standard Lime & Cement Co., both of Martinsburg. Output was for building brick and cement manufacture.

Boone.—Coal production increased 25 percent with eight new mines in operation. The county continued as eighth ranking in coal output. Of total production, 84 percent was mined at 50 underground mines, 9 percent at 8 auger mines, and 7 percent at 4 strip mines. Auger production increased significantly, and the county was second ranked in auger production. Of the underground production, 93 percent was mechanically loaded, two-thirds by 46 mobile loaders and one-third by 9 continuous miners. This was a decrease of seven continuous miners; the decrease was caused by the closing of the Wharton No. 1 mine of Eastern Gas & Fuel Associates in 1962. Six cleaning plants, four of which had thermal drying equipment, prepared 79 percent of output. Ranger Fuel Co. began strip and auger mining in 1963, contributing in a large measure to increased coal output from surface mining operations. The leading producers at underground mines were

TABLE 9.—Value of mineral production in West Virginia, by counties[1]

County	1962	1963	Mineral production in 1963 in order of value[2]
Barbour	(3)	$12,140,987	Coal, stone.
Berkeley	$16,965,533	15,872,596	Cement, stone, lime, clays.
Boone	26,940,646	32,480,214	Coal.
Braxton	(3)	(3)	Coal, stone.
Brooke	3,123,283	3,467,899	Coal, sand and gravel.
Cabell	(3)	(3)	Sand and gravel, clays.
Clay	(3)	(3)	Coal.
Doddridge	(3)	44,136	Stone.
Fayette	22,333,025	24,252,827	Coal.
Gilmer	4,364,155	4,610,828	Coal.
Grant	(3)	(3)	Stone, coal.
Greenbrier	(3)	(3)	Coal, stone.
Hampshire	75,000	26,000	Stone.
Hancock	(3)	(3)	Clays, sand and gravel.
Hardy	22,248	(3)	Stone.
Harrison	(3)	(3)	Coal, stone.
Jefferson	(3)	(3)	Stone, lime.
Kanawha	46,637,096	45,173,193	Coal, salt, stone, clays, calcium-magnesium chloride.
Lewis	1,038,580	1,340,131	Coal, stone, clays.
Lincoln	77,103	(3)	Coal, sand and gravel.
Logan	67,546,519	71,897,345	Coal.
McDowell	88,287,617	99,555,784	Do.
Marion	48,906,745	47,693,854	Do.
Marshall	(3)	(3)	Coal, salt.
Mason	(3)	(3)	Coal, salt, sand and gravel.
Mercer	6,009,669	8,215,999	Coal, stone, clays.
Mineral	(3)	531,932	Coal, stone, sand and gravel.
Mingo	26,789,373	28,101,056	Coal.
Monongalia	30,100,106	37,364,059	Coal, stone, sand and gravel.
Morgan	(3)	(3)	Sand and gravel.
Nicholas	(3)	31,140,868	Coal, stone.
Ohio	(3)	(3)	Coal, sand and gravel.
Pendleton	284,672	369,358	Stone.
Pleasants	(3)	(3)	Salt.
Pocahontas	(3)	(3)	Coal, stone.
Preston	(3)	(3)	Do.
Putnam	370,766	201,680	Coal.
Raleigh	34,794,706	40,606,716	Coal, stone, sand and gravel.
Randolph	(3)	(3)	Coal, stone.
Ritchie	86,005	----------	
Taylor	(3)	(3)	Coal, clays.
Tucker	273,294	(3)	Coal, stone, sand and gravel.
Tyler	(3)	(3)	Sand and gravel, salt.
Upshur	5,115,453	3,320,488	Coal, stone.
Wayne	282,025	(3)	Coal, sand and gravel.
Webster	3,359,448	4,971,295	Coal.
Wetzel	(3)	(3)	Sand and gravel.
Wood	(3)	(3)	Do.
Wyoming	55,599,494	66,511,297	Coal, sand and gravel.
Undistributed	[4] 226,081,686	187,924,382	
Total	[4] 715,464,000	767,815,000	

[1] Calhoun, Jackson, Monroe, Roane, Summers, and Wirt Counties are not listed because no production was reported.
[2] Excludes natural gas, natural gas liquids, petroleum, gem stones, and some stone not assigned to specific counties, included with "Undistributed."
[3] Figure withheld to avoid disclosing individual company confidential data, included with "Undistributed."
[4] Revised figure.

Westmoreland Coal Co., Eastern Gas & Fuel Associates, and Armco Steel Corp.

Braxton.—One additional coal mine was put into operation. Output from the four underground mines decreased from that of 1962. Most of the production was mechanically loaded by two mobile loading machines and was washed at the Lizanne cleaning plant of Guardian Coal Co.

Meadow Stone & Paving Co. produced crushed sandstone for road construction at plants near Gassaway and Holly.

Brooke.—Coal production increased 18 percent over that of 1962. Of total output, 53 percent was mined at four underground mines, 44 per-

cent at six strip mines and 3 percent at two auger mines. Windsor Power House Coal Co. operated the largest underground mine and Tri-State Coal Mining Co., Inc., the largest strip mine. Most of the underground production was mechanically loaded by four mobile loading machines. Weirton Ice & Coal Supply Co. (formerly Half Moon Coal Co.) operated a merchant preparation plant and Windsor Power House Coal Co. prepared its captive output for a power plant.

Duquesne Sand Co. operated a dredge near Beech Bottom and produced building and paving sand and building gravel. The Brilliant Materials Co. (formerly Brilliant Sand Co.) produced fire and furnace sand and fill gravel near Follansbee.

Cabell.—Sand and gravel was dredged from the Ohio River near Huntington by Ohio River Dredging Co. and Union Sand & Gravel Co., chiefly for building and paving. Clay (red shale) was mined by Barboursville Clay Manufacturing Co., Barboursville, for manufacturing building brick and tile.

Clay.—Six underground coal mines were in operation. The auger mine of Calrite Coals, Inc., did not operate in 1963. Clinchfield Coal Co. abandoned its Rich Run mine and cleaning plant as of December 31, 1963, idling 200 men.

Doddridge.—Feather Construction Corp. reported increased output of crushed sandstone aggregate from its Doddridge "K" plant near West Union.

Fayette.—Coal production increased 13 percent as 14 new mines were in operation, bringing the total to 192. Of total output, 91 percent was mined at 185 underground mines, 5 percent at 4 auger mines, and 4 percent at 3 strip mines. The Ranger Fuel Corp. was the leading strip and auger producer. Leading underground mining companies were Allied Chemical Corp., The New River Co., Clifftop Smokeless Coal Co., Ranger Fuel Corp., and Milburn Colliery Co. Of the underground production, 78 percent was mechanically loaded. Of this tonnage, 62 percent was loaded by 59 mobile loaders, 35 percent by 15 continuous miners, and 3 percent by 22 hand-loaded face conveyors. Ten cleaning plants prepared 68 percent of output. Two new heavy media plants were put into operation in 1963, one each by Ranger Fuel Corp. and Sparks Coal Co. Ames Mining Co. closed its mine in March, idling 72 men, but Mary Frances Coal Co., The New River Co., and Riverton Coal Co. opened mines in 1963 employing a total of 83 men.

Gilmer.—Although the number of active coal mines decreased by five, production increased 8 percent. Most of the output came from 10 underground mines; only one auger mine was in operation. Randolph Brothers closed its strip and auger mines. Rochester & Pittsburgh Coal Co. was the leading producer operating a mechanized underground mine and jig preparation plant.

Basil R. Heavner did not operate the Furr sandstone quarry near Glenville in 1963.

Grant.—Stone & Webster Engineering Corp. leased the Stony River Sandstone quarry of Garbert Construction Co., Inc., and used material from a borrow area of the quarry for a rock fill dam on the Stony River near Mt. Storm.

747-416—64——75

Limestone output, reported by Bean's Lime & Stone Co., Inc., Petersburg, and Keplinger Lime Co., Inc., Maysville, for concrete aggregate and agstone, was virtually unchanged from 1962.

Five coal mines were in operation, three less than in 1962. Output dropped significantly.

Greenbrier.—Coal production increased 38 percent as 11 new mines were put into operation. Most of the underground mines were small hand-loading operations. Only one strip mine, operated by Milem Construction Co., was active. Leckie Smokeless Coal Co. did not operate its heavy media preparation plant in 1963.

The county was the third ranked limestone-producing area. Output was reported by Acme Limestone Co. and The H. Frazier Co., Inc., both of Fort Spring, for use as aggregate, railroad ballast, and agstone.

Hampshire.—Williams Quarry, Inc., quarried limestone near Romney for use as concrete aggregate and roadstone.

Hancock.—Reduced markets for building sand and gravel decreased sand and gravel production in 1963, but the county continued to rank first in output of this commodity. Dravo Corp. operated its Nos. 9 and 16 dredges on the Ohio River near New Cumberland, and Volino Bros. operated a stationary plant near Arroyo.

The county also was first ranked in clay production. Plastic fire clay was mined by The Globe Brick Co., Newell; Crescent Brick Co., Inc., and West Virginia Fire Clay Manufacturing Co., both of New Cumberland. Output was for ladle brick, firebrick and block, foundries and steelworks. Crescent Brick Co. (after 40 years of operation) merged with Resco Products, Inc., of Philadelphia, but will maintain its identity. The Globe Brick Co. installed new materials handling equipment in 1963.

Hardy.—The Baker Lime plant of the State Soil Conservation Service, Potomac Valley district, produced crushed limestone for aggregate and agstone. The company began an underground operation at its quarry site.

Harrison.—Despite a 10-percent increase in coal production, the county dropped from sixth to ninth place among the coal-producing counties. The number of mines in operation dropped by 7 to 96. Of total production 80 percent was mined at 66 underground mines, 16 percent at 21 strip mines, and 4 percent at 9 auger mines. The county ranked first in strip mining and third in auger mining. Equipment at strip mines included 31 power shovels, 4 draglines, 34 bulldozers, 2 carryall scrapers, and 62 trucks which averaged 13 tons in capacity. Leading strip producers were Yochym Bros. Coal Co. and Petitto Bros. Coal Co. Of the underground production, 94 percent was loaded mechanically. Continuous mining increased sharply as 11 new machines (a total of 23) were put into use. Ten fewer mobile loaders (a total of 41) were in use. Seven cleaning plants, four of which had thermal drying equipment, prepared 54 percent of output; 44 percent was crushed. Leading underground mining companies were Clinchfield Coal Co. and Mountaineer Coal Co. Mine closings in 1963 included mines of the McCandlish Coal Co. and the Miami Coal Co. Mine openings included Mountaineer Coal Co.'s Consol strip and the new strip and auger mines of the Panora Co., Inc.

North View Stone Co., Clarksburg, and Salerno Bros., Inc., Pine Bluff, produced crushed sandstone for concrete aggregate. Paul Harrold increased production of limestone for aggregate at a quarry near Wolf Summit.

Jefferson.—Limestone production decreased 6 percent, but the county remained in second place among the limestone-producing counties. Producers were Michigan Limestone Division, United States Steel Corp.; Blair Limestone Division, Jones & Laughlin Steel Corp.; and Standard Lime & Cement Co., Division of Martin-Marietta Corp., all of Millville. Output was chiefly for flux, the manufacture of dead-burned dolomite, and railroad ballast.

Refractory lime was produced by Standard Lime & Cement Co. at Millville. Production, which was shipped mostly to Pennsylvania, dropped in 1963. Calcareous marl for agricultural uses was produced by West Virginia Lime Co., Charles Town.

The Millville quarry of Jones & Laughlin Steel Corp. received a certificate of achievement in safety for working the year without a disabling work injury.

Kanawha.—Six additional coal mines were in operation and production increased 6 percent, but the county dropped from third to fourth ranking in coal production in the State. Of total output, 84 percent was mined at 122 underground mines, 10 percent at 9 auger mines, and 6 percent at 6 strip mines. Strip production increased sharply. Oglebay-Norton Co., The Carbon Fuel Co., and Perry & Hylton, Inc., were the leading strip producers. The county led in auger production with output of over 1 million tons, 30 percent of the State auger production. The Carbon Fuel Co., Robbin Coal Co., and Oglebay-Norton Co. were the leading auger mining companies. Of the underground production, 95 percent was mechanically loaded, most of which was handled by 88 mobile loaders. In addition, 12 continuous miners and 5 hand-loaded face conveyors were in use. Leading producers were The Carbon Fuel Co., Oglebay-Norton Co., Union Carbide Corp., The Valley Camp Coal Co., and Cannelton Coal Co., which combined produced over two-thirds of the county output. Nine cleaning plants prepared 61 percent of output; 51 percent was crushed and 11 percent was treated with oil. Mine closings included Fields Creek Coal Co.'s Peerless No. 3 mine; The North American Coal Corp.'s underground and strip mines; Oglebay-Norton Co. No. 18 mine; and Union Carbide Corp. Bell Creek Nos. 1 and 2 mines. New mines included Cannelton Coal & Coke Co. (90 employees); Imperial Colliery Co., two mines (50 employees); Union Carbide Corp., two mines (112 employees); and The Riverton Coal Co. (37 employees). The Bell Creek Nos. 1 and 2 mines of Union Carbide Corp. received a certificate of achievement in safety for its outstanding safety record, working the year without a disabling work injury.

Inorganic Chemical Division, FMC Corp. produced well brines at South Charleston for the manufacture of chlorine. A quantity of calcium-magnesium chloride was recovered from the naturally occurring brines. Brines recovered from rock salt formations near Bens Run in Tyler and Pleasants Counties also were processed at South Charleston.

Tony Pacifico Co. quarried dimension and crushed sandstone near Charleston for ganister, flagging, and irregular shaped building stone. Mazella Quarries, Inc., South Charleston, produced crushed sandstone for concrete aggregate.

Fire clay was produced by West Virginia Brick Co. and Charleston Clay Products Co., both of Charleston. Output was for building brick and tile. The latter company reported improving its ventilating system at its underground clay mine.

Lewis.—Increased coal production from strip and underground mines offset the loss in production caused by the closing of two large auger mines. Total output increased 24 percent. Active in 1963 were two underground, strip, and auger mines. Keeley Construction Co. and Admiral Mining Co. closed their auger mines. Bitner Fuel Co. was the leading strip producer. At underground mines there was no mechanical loading, and none of the output was mechanically cleaned, owing to the closing of Keeley Construction Co.'s preparation plant. However, 98 percent of total output was crushed.

Sandstone production was four times greater in 1963 as Anderson's Black Rock, Inc., began operating in the county, transferring quarrying equipment from its former Ritchie County operation. In addition, Weston Stone Co. quarried sandstone also for use in road construction.

Weston-Jane Lew Brick & Tile Co. mined miscellaneous clay for building brick.

Lincoln.—Coal was dredged from the Guyandot River by Davis & Adkins Coal & Sand Co., Ferrellsburg Coal & Sand Co., and Dial Coal Co. The latter company also recovered sand for coal-mine engine traction.

Logan.—Coal production increased 5 percent and the county continued to rank first among the coal-producing counties. Most of the output was from 62 underground mines; 8 auger mines and 1 strip mine also were active. Almost all of the underground production was loaded mechanically mainly by 173 mobile loading machines (89 percent). Sixteen continuous miners, an increase of four over the number used in 1962, loaded 11 percent. Eighteen cleaning plants, five of which had thermal drying equipment, prepared 81 percent of output. This was one less plant than in 1962 as Island Creek Coal Co. closed its Elk Creek mine and plant. The leading coal producers, whose combined production totaled two-thirds of output, were Island Creek Coal Co., Amherst Coal Co., Omar Mining Co., and Boone County Coal Corp. New mines opening in 1963 included Chafin Coal Co., No. 3 mine; Island Creek Coal Co., Nos. 10 and 33 mines; Jewell Ridge Coal Co., Alma No. 2 mine; Raleigh Eagle Coal Co., Rex No. 2 mine; and Spruce River Coal Co., No. 11 mine. Employed at these new mines were nearly 300 men. Significant among the mines closing was Lorado Coal Mining Co., Inc., which closed its Nos. 8 and 10 mines in September idling 140 men.

McDowell.—Coal production increased 17 percent as 35 new underground mines and 2 new auger mines were put into operation bringing the total to 238 mines. The county continued to rank second in coal production. Of total production, 95 percent was mined at 222 underground mines, the balance at 7 strip and 9 auger mines. Of the

underground production, 89 percent was mechanically loaded. Of this total, 80 continuous miners loaded 72 percent; 62 mobile loaders 27 percent and 14 hand-loaded face conveyors and 4 duckbills the balance. There were 21 cleaning plants, 6 of which had thermal drying equipment, that prepared 91 percent of output. Dry Fork Pocahontas Coal Co. began cleaning coal for other mines in the area. Cannelton Coal Co. resumed operation of its No. 4 mine which had been idle since 1961, and U.S. Steel Corp. reactivated its old No. 1 mine at Wilcoe which had been abandoned since 1905. The leading coal producers were U.S. Steel Corp., Island Creek Coal Co., Eastern Gas & Fuel Associates, Bishop Coal Co., and Olga Coal Co. with combined output comprising over two-thirds of county coal output. The Gary Contour mine of U.S. Steel Corp. at Munson received a certificate of achievement in safety for its outstanding safety record in 1963.

Marion.—Coal production was virtually unchanged from that of 1962, and the county continued to rank fifth among the coal-producing counties. Almost all the output was from 11 underground mines. Virtually all the underground output was mechanically loaded, chiefly by 55 continuous mining machines (3 more than in 1962). In addition, 43 mobile loaders were used behind continuous miners, loading the cut coal into shuttle cars. Almost the total county output was mechanically cleaned at eight preparation plants, six of which had thermal drying equipment. Leading producers were Mountaineer Coal Co. (three mines), Bethlehem Mines Corp. (two mines), Rochester & Pittsburgh Coal Co., and Joanne Coal Co.

Marshall.—Three underground coal mines were in operation. Hanna Coal Co. and The Valley Camp Coal Co. mined most of the output with 19 continuous miners, 4 more than in 1962. These companies each operated a preparation plant cleaning 80 percent of output.

The county ranked first among the salt-producing counties. Output was consumed as brine in manufacturing chlorine and other chemicals. Producers were Pittsburgh Plate Glass Co., New Martinsville, and Solvay Process Division, Allied Chemical Corp., Moundsville.

Mason.—Coal production decreased 4 percent even though one additional mine was in operation. Of total output, 74 percent was mined at 12 underground mines, 25 percent at 2 strip mines and 1 percent at 1 auger mine. Loading of underground production was almost equally divided by 11 mobile loading machines and 13 hand-loaded face conveyors. There was no mechanical cleaning, but 69 percent of output was crushed. Rickard Coal Co. abandoned its mine in June idling 22 men.

Liverpool Salt Co., Hartford, produced evaporated salt for sale to feed dealers, water softener manufacturers, meat packers, and groceries.

Slackened demand for building and paving aggregates caused decreased production of sand and gravel. Producers were Mason Aggregates, Inc., West Columbia, and Letart Sand & Gravel Co., Letart.

Mercer.—Coal production increased 42 percent as 10 additional mines were in operation in 1963. Auger mining continued its sharp rise,

increasing over 5 times that mined in 1962. Underground mining also increased as 11 new mines were active. Of total output, 81 percent was mined at 40 underground mines, 14 percent at 3 strip mines, and 5 percent at 8 auger mines. At the undeground mines, 14 mobile loaders and 1 continuous miner loaded most of the output. McComas Coal Co. and S. & H. Coal Co. opened new auger mines in 1963. Arista Coal Mining Co., Inc., and R & M Coal Co. reported increased production at their underground mines.

Oakvale Stone Co., Princeton, produced crushed sandstone for concrete aggregate. Virginian Brick & Tile Co. mined miscellaneous clay near Princeton for building brick and other heavy clay products.

Mineral.—Coal production increased 42 percent. Output was entirely from six underground mines. Hampshire Mining Corp. reported increased production from its two operations. There was no mechanical loading or cleaning, but 54 percent of output was crushed.

Limestone was produced for concrete aggregate and roadstone by Aurora Stone Co., Thomas; Spencer Lime Co., Keyser; and Fry Coal & Stone Co., Division of Martin-Marietta Corp., Pinto. Sand and gravel was produced for building aggregate by Potomac Sand & Stone Co., Keyser.

Mingo.—Coal production from 103 mines was 4 percent greater than in 1962. Of total production, 96 percent was mined at 97 underground mines, the balance from 1 strip mine and 5 auger mines. At the underground mines, 74 mobile loading machines (21 more than in 1962) and 8 continuous miners loaded most of the output. Eight cleaning plants, six of which had thermal drying equipment, prepared 80 percent of output. The leading producers were Island Creek Coal Co. and National Coal Mining Co. Massey Coal Mining Co. discontinued mining at its Ben Creek No. 2 mine, but continued operation of its cleaning plant servicing truck mines in the area. Ames Coal Co. opened a new mine in November.

Monongalia.—Coal production increased 30 percent, and the county rose from ninth to seventh ranking among the coal-producing counties. Mines in operation increased by 14 to 64. Most of the production was from 60 underground mines. Almost all of the underground production was loaded mechanically by 16 mobile loaders and 27 continuous miners (5 more than in 1962). Three cleaning plants, one of which had thermal drying equipment, prepared 68 percent of output. Christopher Coal Co. was the leading producer.

Limestone was quarried by Green Bag Cement Co., Division of Marquette Cement Manufacturing Co., Morgantown, and Greer Limestone Co., Greer. Output was used for concrete aggregate, in the manufacture of cement, for railroad ballast, agstone, and riprap.

Sand for glass manufacture and engine traction was produced by Deckers Creek Sand Co. at a stationary plant near Masontown.

Morgan.—Industrial sand and ground sand was produced by Pennsylvania Glass Sand Corp. at its Berkeley Works near Hancock. Output was mostly for glass and abrasive manufacture. The county ranked first in value but second in tonnage among the sand- and gravel-producing counties.

Nicholas.—The county was the 10th ranked among the coal-producing counties. Output increased 14 percent over 1962, even

though the number of active mines dropped by 7 to 109. Of total production, 93 percent was mined at 98 underground mines, 4 percent at 5 strip mines and 3 percent at 6 auger mines. Mechanical loading by continuous miners increased significantly as the new mines opened by Birch Coal Co. and Summersville Coal Co. used 10 and 12 continuous miners, respectively. All told, 62 continuous miners, 45 mobile loaders, and 63 hand-loaded face conveyors were in operation. Strip production increased sharply, owing to increased mining activity by Janutolo Construction Co., Inc., and Imperial Coal & Construction Co. Nine cleaning plants, five of which had thermal drying facilities, were in operation preparing 76 percent of output. Gauley Coal & Coke Co. was the leading producer. Companies opening mines during 1963 included Birch Coal Co., Gauley Coal & Coke Co., Sewell Coal Co., and Summersville Coal Co. These mines provided employment for over 300 men. However, Oglebay-Nortion Co. closed its Burton mine in November idling almost 100 men.

Nettie Sand Co. produced crushed sandstone at Nettie for concrete aggregate and roadstone.

Ohio.—The Valley Camp Coal Co. mined the entire output of coal in 1963 as the Dependable Coal Co. abandoned its mine in December 1962. The entire output was mechanically loaded and cleaned.

Sand and gravel for building aggregate was produced by Delta Concrete Co. from a dredge on the Ohio River. The Ohio River Sand & Gravel Co. did not operate its dredge in the county in 1963.

Pendleton.—Crushed limestone was produced by Germany Valley Limestone Co., Division of Greer Limestone Co., and North Fork Lime Producers Cooperative, Inc., both of Riverton, and Ruddle Lime Co., Franklin. Output was mainly for concrete aggregate and agstone.

Pleasants.—Inorganic Chemical Div., FMC Corp. produced salt brine near Bens Run for shipment to South Charleston for chlorine manufacture.

The Ohio River Sand & Gravel Co. did not operate its dredge in the county in 1963.

Pocahontas.—Coal production dropped 60 percent, mainly because of the mine closings by Beckley Coal & Coke Co. and Gauley Coal & Coke Co. in 1962. Nine underground and one auger mine were in operation in 1963. Most of the underground production was mechanically loaded by four continuous miners and nine hand-loaded face conveyors. There was no mechanical cleaning in the county.

Terra Alta Limestone Co. produced crushed limestone near Marlinton for concrete aggregate and roadstone.

Preston.—Coal production increased 16 percent over that of 1962. There were 8 additional mines in operation, bringing the total to 115. Of total production, 70 percent was produced at 95 underground mines, 29 percent at 17 strip mines and 1 percent at 3 auger mines. Strip production increased significantly; the county was second ranked in strip output. Kingwood Mining Co., Daugherty Coal Co., Inc., and Mary Ruth Corp., the leading strip-mining companies, all reported increased mining activity. Equipment in use at strip mines included 38 power shovels, 4 draglines, 24 bulldozers, and 64 trucks which averaged 17 tons in capacity. Criterion Mining Co. abandoned its auger mine, contributing to the large drop in auger produc-

tion. Of the underground production, 45 percent was mechanically loaded by a combination of 13 mobile loaders, 3 continuous miners, and 11 hand-loaded face conveyors. Chapel Coal Co. and Sandy Creek Fuel Corp. were the leading underground producers. Four cleaning plants, one with thermal drying equipment, prepared 23 percent of ouput. Dunbar Coal Co. opened a new mine and preparation plant in May, and Chapel Coal Co. opened a new mine in June employing 31 men.

Preston Limestone Co., Inc., Kingwood, produced crushed limestone for concrete aggregate and agstone. Terra Alta Limestone Co. did not operate its Aurora quarry. Dimension sandstone was quarried for cut stone, flagging, and irregular shaped stone by Brookside Stone Co. near Brookside.

Putnam.—Coal production by 12 underground and 1 strip mine decreased significantly in 1963. There was no crushing, treatment, mechanical loading or cleaning of the coal output.

Raleigh.—Coal production increased 21 percent, and the county rose to sixth from seventh place among the coal-producing counties. Thirteen additional mines were in operation in 1963. Of total production, 95 percent was produced at 120 underground mines, 3 percent at 7 strip mines, and 2 percent at 4 auger mines. Auger production increased sharply owing to the output of the new auger mine opened in June by Winding Gulf Coals, Inc. Underground production, which also increased, was mostly loaded by mechanical means. Seventy-seven mobile loaders (18 more than in 1962), 20 continuous miners, 4 duckbills, and 30 hand-loaded face conveyors were in use. Fourteen cleaning plants prepared 78 percent of output. Leading producers were Winding Gulf Coals, Inc., Slab Fork Coal Co., Eastern Gas & Fuel Associates, Armco Steel Corp., and Oglebay-Norton Co., whose combined production comprised three-fourths of county output. Oglebay-Norton Co. opened two new mines early in 1963 employing 85 men.

Production of crushed sandstone was greatly increased over that of 1962. Raleigh Stone Co. operated its Sullivan quarry near Glen Morgan and produced a large tonnage of crushed sandstone for aggregate use. The Table Rock sand plant continued operation of its quarry near Beckley. Increased production of sand for building block manufacture was reported by Beaver Block Co., Beaver.

Randolph.—Coal production increased 43 percent over that of 1962. Both underground and strip mining increased significantly, but there was no auger mining as the county's two auger mines were abandoned in 1962. Of total output, 88 percent was mined at 32 underground mines, the balance at 5 strip mines. Of the underground production, 77 percent was mechanically loaded by a combination of 16 continuous miners, 4 mobile loaders, and 22 hand-loaded face conveyors. Grafton Coal Co. sold its two underground mines to A.C. & H. Coal Co. in October. Kittanning Coal Co., Inc., operated a pneumatic preparation plant in 1963.

Elkins Limestone Co., Elkins, and Sam G. Polino & Co., Bowden, quarried and crushed limestone for concrete aggregate, railroad ballast, and agstone.

Ritchie.—Anderson's Black Rock, Inc., closed its quarry in 1963 and transferred its mining equipment to a quarry in Lewis County.

Taylor.—Coal production dropped 6 percent even though seven new mines were in operation in 1963. Of total output, 39 percent was produced at 25 underground mines, and the balance at 4 strip and 2 auger mines. One mobile loading machine was in use; the balance of underground output was from small hand-loading operations.

The Grafton Brick Co. mined shale near Thornton for building brick.

Tucker.—Coal production more than doubled in 1963 largely because of increased strip production. B.B. & J. Coal Co. and Douglas Coal Co., large strip mine operators, were the leading producers.

Elkins Asphalt Co. quarried and crushed limestone near Parsons for use as aggregate. Sand for building and paving was produced by Fairfax Sand & Stone Co.

Tyler.—Production of sand and gravel by the Ohio River Sand & Gravel Corp. at its dredge on the Ohio River increased sharply to fill the void caused by the closing of the company's dredging operations in Ohio, Pleasants, and Wetzel Counties. Output was chiefly for paving aggregate, but smaller quantities were used for railroad ballast and fill. The county ranked third in sand and gravel production.

Salt brines were produced from wells near Bens Run by Inorganic Chemical Division, FMC Corp. for shipment by barge to the company's chemical plant at South Charleston.

Upshur.—Coal production decreased 33 percent from that of 1962. Of total output, 92 percent was produced at 25 underground mines and 8 percent at 3 strip mines. Decreased coal markets caused lower production rates by the leading producers, Reppert Fairmont Coal Co. and Peck's Run Coal Co. A further reduction was caused by the closing of Hacker's Creek Coal Co. mine in May. At the underground mines, 10 mobile loading machines and 4 continuous miners loaded 85 percent of output. Three cleaning plants, one with thermal drying equipment, prepared 65 percent of output; 66 percent was crushed.

Basil R. Heavner quarried and crushed sandstone near Buckhannon for concrete aggregate and roadstone.

Wayne.—Seven underground coal mines, an increase of three, were in operation. Coal production increased 11 percent. Of total output, 68 percent was loaded by two mobile loading machines. There was no cleaning, crushing or treatment.

Laval Sand Co., Inc., Fort Gay, produced sand for building aggregate and for coal-mine engine traction.

Webster.—Increased markets for the county's coal production caused a 49-percent increase in coal output in 1963. The leading underground producers reported increased output. They were Johnstown Coal & Coke Co., Cherry River Coal & Coke Co., Coon Coal Co., and Sugar Creek Corp. Strip production also increased sharply due to the production of the new strip mine opened by Cherry River Coal & Coke Co. At the underground mines, 68 percent of output was mechanically loaded by a combination of 6 mobile loading machines, 9 continuous miners, and 15 hand-loaded face conveyors. Three cleaning plants prepared 79 percent of output.

Wetzel.—Ohio Valley Sand Co., Inc., produced sand and gravel near New Martinsville for building and paving aggregate. Ohio River Sand & Gravel Co. did not operate its dredge in the county in 1963.

Wood.—Sand and gravel was produced by Pfaff & Smith Builders Supply Co. and Kanawha Sand Co., Parkersburg, mainly for building and paving aggregates. Ohio River Sand & Gravel Co., operator of two dredges in the county in 1962, was idle in 1963.

Wyoming.—The county rose from fourth to third place in rank among the coal-producing counties. Fourteen additional mines were in operation, and production increased 21 percent. Most of the output was mined at 84 underground operations; two strip mines and one auger mine also were active. Of the underground production, 94 percent was mechanically loaded, of which 64 percent was loaded by 114 mobile loaders (22 more than in 1962); 35 percent by 51 continuous miners (12 more than in 1962); and the balance by 9 hand-loaded face conveyors. Leading underground mining companies were Eastern Gas & Fuel Associates, Itmann Coal Co., and Island Creek Coal Co. Of total output, 93 percent was mechanically cleaned at 14 preparation plants, 5 of which had thermal drying equipment. Island Creek Coal Co. closed its Wyoming mine in October but opened a fully mechanized new mine with a preparation plant in the same month. Nell Jean Coal Co., Inc., abandoned its mine in October. Consolidation Coal Co. and National Steel Corp. formed the jointly-owned Itmann Coal Co. in January to produce low-volatile metallurgical coal.

Sand was produced by Tolers Sand Co. at Clear Fork for use as traction sand for coal-mine engines.

The Mineral Industry of Wisconsin

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Wisconsin for collecting information on all minerals except fuels.

By Wesley A. Grosh [1]

VALUE of mineral production in Wisconsin was $68.3 million in 1963, virtually unchanged from the 1962 value. Nonmetals represented 84 percent of the value of minerals produced in the State. The value of metals produced decreased 5 percent, and the value of nonmetals increased 1 percent.

A constant dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current dollar value by the appropriate group implicit price deflator.

TABLE 1.—Mineral production in Wisconsin [1]

Minera	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasive stones: Grinding pebbles---short tons	569	$17	561	$21
Clays---thousand short tons	137	156	111	140
Iron ore (usable)---thousand long tons, gross weight	1,045	(2)	938	(2)
Lead (recoverable content of ores, etc.)---short tons	1,394	256	1,116	241
Peat---do	(2)	(2)	2,667	136
Sand and gravel---thousand short tons	33,649	24,408	35,633	26,348
Stone---do	13,392	19,709	13,583	18,744
Zinc (recoverable content of ores, etc.)---short tons	13,292	3,057	15,114	3,476
Value of items that cannot be disclosed: Abrasive stones—tube-mill liners (1963), cement, gem stones, lime, and values indicated by footnote 2		20,686		19,220
Total		68,289		68,326

[1] Production as measured by mine shipments, sales, or marketable production (including cousumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.

[1] Supervising mining engineer, Bureau of Mines, Minneapolis, Minn.

TABLE 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1952	$63,003	1958	$73,056
1953	59,389	1959	71,276
1954	58,234	1960	77,575
1955	68,633	1961	73,148
1956	64,560	1962	68,191
1957	70,250	1963	67,823

Consumption, Trade, and Markets.—Production of sand and gravel and crushed stone increased slightly in 1963, although production of portland cement decreased. Value of clay production decreased. Peat production showed a substantial decrease in value and quantity. The increase in lead and zinc prices during the last half of the year resulted in increased exploration and development activity in the southwestern part of the State. Although the quantity and value of iron ore shipments decreased only 10 and 12 percent, respectively, much of the ore shipped was from stockpiles mined in previous years, reflecting the continued decline in the competitive position of underground direct-shipping ores.

Trends and Developments.—Several lead-zinc companies in southwestern Wisconsin started reconditioning their mines and mills preparatory to starting mining operations. Two zinc producers idle for over a year began production, and two others plan to resume production in 1964. There was continued interest in the development of a taconite operation in the Black River Falls area, evidenced by the application of one company for a permit to divert processing water from the Black River.

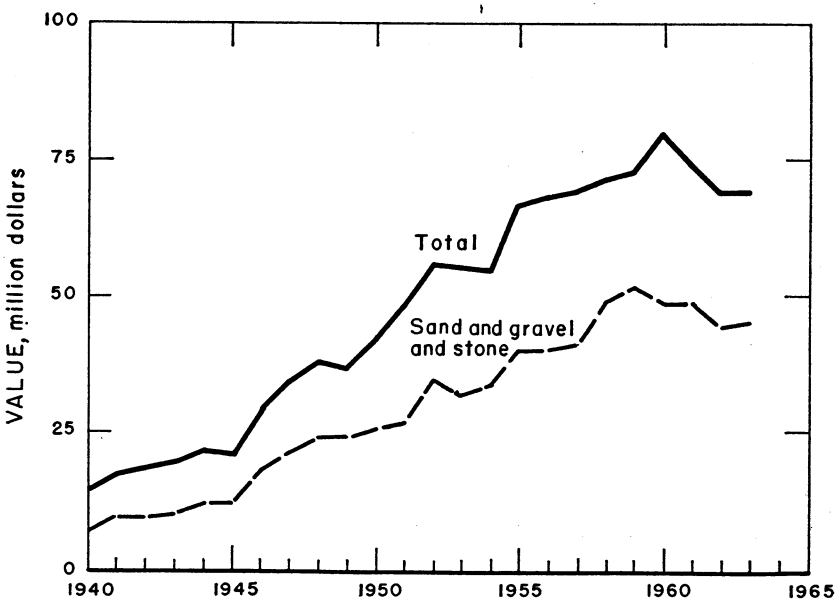


FIGURE 1.—Value of sand and gravel, and stone, and total value of all minerals produced in Wisconsin, 1940–63.

Employment and Injuries.—Over 7.9 million man-hours were worked in Wisconsin mineral industries in 1963, excluding officeworkers. This represented a 10-percent decrease from the 8.8 million man-hours recorded for 1962. Declines in the iron ore, limestone, and sand and gravel industries were chiefly responsible for the overall drop.

Three fatalities, one each at limestone, sand and gravel, and coke oven operations, occurred in 1963, compared with six in 1962. The total number of nonfatal disabling injuries decreased to 198 (preliminary figure), compared with the final figure of 282 for 1962.

Table 3 contains a summary of employment and injury data for selected State mineral industries. Certain industries are excluded from the table, primarily to avoid disclosing individual company confidential data.

TABLE 3.—Employment and injuries for selected mineral industries [1]

Year and industry	Average number of men working	Total man-hours	Total number of disabling injuries		Total number of days lost or charged	Injury frequency rate [2]	Injury severity rate [3]
			Fatal	Nonfatal			
1962:							
Granite	119	227,346	--	10	370	43.99	1,627
Limekiln [4]	114	277,147	--	15	193	54.12	696
Limestone [5]	1,241	1,725,570	1	48	7,148	28.40	4,142
Sand and gravel [6]	2,352	3,565,332	2	86	13,973	24.68	3,919
Sandstone	146	251,371	--	8	297	31.83	1,182
1963: [7]							
Granite	175	329,538	--	22	(8)	66.76	(8)
Limekiln [4]	119	282,347	--	8	(8)	28.33	(8)
Limestone [5]	1,109	1,658,081	1	45	(8)	27.74	(8)
Sand and gravel [6]	2,210	3,375,123	1	42	(8)	12.74	(8)
Sandstone	143	236,872	--	5	(8)	21.11	(8)

[1] Excludes officeworkers.
[2] Total number of injuries per million man-hours.
[3] Total number of days lost or charged per million man-hours.
[4] Includes quarries producing limestone used in manufacturing lime.
[5] Excludes quarries producing limestone used in manufacturing cement and lime.
[6] Excludes friable sandstone, which is included under "sandstone."
[7] Preliminary data.
[8] Data not available.

Water.—To obtain valid data concerning water use by the mineral industries for 1962, the Bureau of Mines conducted a nationwide canvass of virtually all mineral extractive and certain mineral processing industries. Cement plants, lime plants, and other manufacturing-type operations were excluded. Table 4 summarizes some of the data collected for the State. As used in the table, "new water" is that entering the plant as makeup water and when added to the "recirculated water" gives the total used or required for processing. "Water discharged" is used water leaving the plant. "Water consumed" is that which leaves the plant as moisture combined or entrained in the product or lost by evaporation and no longer available for reuse in the vicinity of the plant.

TABLE 4.—Water statistics for selected mineral industries in 1962

(Million gallons)

Industry	New water	Water recirculated	Total water used	Water discharged	Water consumed
Iron ore	5		5	5	
Lead-zinc	796		796	795	(1)
Dimension stone	12	15	27	11	1
Crushed stone	192	125	317	176	16
Sand and gravel	865	1,028	1,894	831	35
Other nonmetals	(1)		(1)	(1)	
Total	1,870	1,168	[2] 3,038	[2] 1,819	52

[1] Less than 500,000 gallons.
[2] Data do not add to total shown because of rounding.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Stones.—Baraboo Quartzite Co., Inc. produced grinding pebbles for polishing, deburring, and silica grinding from a quartzite deposit in Sauk County. Quantity of pebbles produced was approximately the same as 1962, but value increased 22 percent.

Cement.—Production of portland cement increased 4 percent, but shipments decreased 6 percent in quantity and 5 percent in value from those of 1962. Production and shipments of masonry cement increased in quantity but decreased in value. Although some cement was shipped from Wisconsin plants to Michigan and Minnesota, demand for portland and masonry cements in Wisconsin was met partly by shipments of over 6.4 million barrels from plants in Illinois, Indiana, Iowa, Minnesota, and Michigan.

The types of cement produced were general use and moderate heat, and high early strength. Capacity of the two producing plants in Wisconsin remained unchanged from that of 1962. The average mill value per 376-pound barrel of portland cement was $3.47, compared with $3.44 in 1962.

Marquette Cement Manufacturing Co. produced portland and masonry cements at Milwaukee by the dry process, using limestone from Michigan and shale from Illinois. One kiln was operated.

Manitowoc Portland Cement Co., subsidiary of Medusa Portland Cement Co., manufactured cement at Manitowoc by the wet process, using limestone from Michigan and clay obtained locally. Four kilns were operated. The company increased the capacity of their distribution terminal in Milwaukee.

Most of the cement produced in the State was shipped in bulk and by truck. Truck shipments decreased over 7 percent, and rail shipments declined slightly. Shipments of cement to concrete product manufacturers, ready-mixed concrete companies, and highway contractors decreased. Shipments to building material dealers and other contractors increased.

Clays.—Miscellaneous clay or shale was produced in Wisconsin by five companies, three fewer than in 1962. Production decreased 19

percent in quantity and 10 percent in value. The value used for clay production is an approximate mining cost, since all of the clay was used by producing companies in the manufacture of clay products. Products made from clay, in decreasing order of quantities of clay used, were cement, building brick, and other heavy clay products. Production of clay decreased 6 percent for manufacturing cement, 46 percent for building brick, and 9 percent for other heavy clay products. Clay was produced in Dunn, Fond du Lac, Manitowoc, Racine, and Waupaca Counties.

Lime.—Production of lime increased 7 percent in quantity and 9 percent in value over that of 1962. Seventy-three percent of the production was quicklime; the remainder was hydrated lime. The Thilmany Pulp and Paper Co. at Kaukauna and the Mayville White Lime Works at Mayville reported production of quicklime for use only in its own plants. Principal uses of chemical and industrial lime produced, in decreasing order of quantities, were for paper manufacture, water purification, metallurgy, sewage treatment, metal polishing, tanning, brick, oil-well drilling, and miscellaneous purposes. Companies producing lime for sale were The Western Lime & Cement Co., with plants in Brown, Dodge, and Fond du Lac Counties; Cutler-La Liberte-McDougall Corp. in Douglas County; and the Rockwell Lime Co. in Manitowoc County.

Perlite and Vermiculite.—Western Mineral Products Co. exfoliated crude vermiculite from Montana and expanded perlite from New Mexico in its Milwaukee plant. Midwest Perlite Co. expanded perlite from Colorado in its Appleton plant. The vermiculite was used principally for loose fill insulation, with plaster aggregate, fireproofing, and acoustical material as additional uses. The use of expanded perlite, in decreasing order of quantity, was for concrete aggregate, building plaster, loose fill insulation, and soil conditioning.

Sand and Gravel.—Sand and gravel was produced in 67 of the 71 counties; however, several producers did not indicate the source of their production. Total production increased 6 percent in quantity and 8 percent in value from that of 1962. Increases in total quantity produced were building, 3 percent; paving, 1 percent; and fill 47 percent.

Commercial sand and gravel production increased 1 percent in quantity and 7 percent in value. Commercial gravel production showed a slight decrease in quantity and value, but commercial sand increased 5 percent in quantity and 23 percent in value. Molding sand production increased over 20 percent in quantity and value. Total sand used for paving increased 27 percent in quantity and 12 percent in value, while gravel used for paving decreased 5 percent in quantity and 7 percent in value.

Production of sand and gravel from Government-and-contractor operations increased 15 percent in quantity and 11 percent in value with sand production increasing over 60 percent in both quantity and value. Gravel production decreased 3 percent in quantity and 7 percent in value.

TABLE 5.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:[1]				
Molding	560	$1,544	690	$1,871
Oil (hydrafrac)	(2)	(2)	300	1,672
Building	3,022	2,418	3,318	2,630
Paving	1,888	1,525	1,320	934
Fill	985	564	1,237	679
Undistributed[3]	208	550	134	306
Total	[4] 6,662	[4] 6,600	6,999	[4] 8,093
Gravel:				
Building	3,124	2,636	3,305	2,735
Paving	11,482	7,936	10,723	7,298
Railroad ballast	303	151	(5)	(5)
Fill	691	332	1,279	722
Other	214	178	439	234
Total	15,814	11,233	15,746	[4] 10,988
Total sand and gravel	22,476	17,833	22,745	19,081
Government-and-contractor operations:				
Sand:				
Building	(6)	(6)	103	49
Paving	2,685	1,414	4,472	2,371
Fill	421	147	408	140
Other	76	33	163	60
Total	3,182	1,594	5,146	2,620
Gravel:				
Building	400	211	35	19
Paving	7,211	4,608	6,996	4,332
Fill	379	162	711	296
Total	[4] 7,991	4,981	7,742	4,647
Total sand and gravel	11,173	6,575	12,888	7,267
All operations:				
Sand	9,844	8,194	12,145	10,713
Gravel	23,805	16,214	23,488	15,635
Grand total	33,649	24,408	35,633	26,348

[1] Includes friable sandstone.
[2] Included with "Undistributed" to avoid disclosing individual company confidential data.
[3] Includes blast, engine, filtration, foundry, glass, and other construction and industrial sands, and items indicated by footnote 2.
[4] Data do not add to total shown because of rounding.
[5] Included with "Other" gravel to avoid disclosing individual company confidential data.
[6] Included with "Other" sand to avoid disclosing individual company confidential data.

Of the commercial sand and gravel production, over 92 percent was transported by truck, 7 percent by railroad, and less than 1 percent by waterway. Eighty-five percent of the commercial sand and gravel was processed and had an average value of $0.90 per ton. Ninety-two percent of the sand and gravel produced by and for Government agencies was processed and had an average value of $0.55 per ton; the unprocessed material was valued at $0.34 per ton.

The 10 leading producers of sand and gravel in Wisconsin, in alphabetical order, were Consumers Company, Division of Vulcan Materials Co., Chicago, Ill.; Jaeger Sand & Gravel Co., Inc., Milwaukee; Janesville Sand & Gravel Co., Janesville; Edward Kraemer & Sons, Inc., Plain; Lyle T. Manley Co., Rockton, Ill.; Manley Sand Division,

Martin Marietta Corp., Rockton, Ill.; Arthur Overgaard, Inc., Elroy; Pepin Shore Silica Sand Co., Inc., Jackson; Plautz Bros., Inc., Willard; and Valley Sand & Gravel Co., Muskego.

Stone.—The total production of stone in Wisconsin increased slightly in quantity but showed a 5-percent decrease in value. Stone produced included limestone, sandstone, granite, basalt, marble, quartzite, and marl. Dimension stone increased 12 percent in quantity and 22 percent in value. Production of crushed and broken stone increased slightly in quantity but decreased 9 percent in value. Dimension limestone increased 13 percent in quantity and 14 percent in value. Production and value of crushed and broken limestone remained approximately the same as in 1962.

Production of dimension stone, in descending order of value, was granite, limestone, and sandstone. All dimension stone production increased in value from 1962 as follows: Granite, 29 percent; limestone, 14 percent; and sandstone, 60 percent. There were 49 producers of dimension stone of whom 32 produced limestone, 8 granite, and 9 sandstone.

TABLE 6.—Limestone sold or used by producers, by uses

Use	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough construction---thousand short tons	12	$95	9	$69
Rubble---do	15	86	21	127
Rough architectural---thousand cubic feet	7	13	26	18
Sawed stone [1]---do	38	124	39	125
House stone veneer---do	374	832	467	1,070
Cut---do	63	195	23	133
Flagging---do	52	51	55	54
Total---approximate thousand short tons [2]	70	1,396	79	[3] 1,595
Crushed and broken:				
Riprap---thousand short tons	60	75	37	55
Concrete aggregate and roadstone---do	10,173	10,212	10,007	9,560
Agriculture---do	1,365	1,792	1,591	2,045
Lime---do	87	78	(4)	(4)
Other [5]---do	63	87	292	376
Total---do	[3] 11,749	12,244	[3] 11,928	12,036
Grand total---do	[3] 11,818	[3] 13,641	12,007	13,631

[1] Excludes house stone veneer.
[2] Average weight of 160 pounds per cubic foot used to convert cubic feet to short tons.
[3] Data do not add to total shown because of rounding.
[4] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[5] Includes limestone for flux, asphalt, fertilizer, filter beds, lime (1963), and other uses.

Crushed limestone was produced in 37 counties, although a few operators failed to report the source of their production. Crushed basalt, granite, sandstone, and marble were also produced. Crushed and broken basalt was produced by The Ruberoid Co. of New York, principally for roofing granules, and by the Bryan Dresser Trap Rock, Inc., for railroad ballast, concrete, and roadstone. Granite production was used chiefly for rough and dressed monumental stone. Dimension limestone comprises less than 1 percent of the quantity of

commercial limestone produced, but 13 percent of the value. The U.S. Aggregate Co. produced marble terrazzo chips from a quarry near Grandview. Minnesota Mining & Manufacturing Co. produced roofing granules from an argillite quarry in Marathon County. Sandstone other than dimension stone, was used, in decreasing order, for railroad ballast, roofing granules, concrete aggregate and roadstone, refractory material (silica brick), cement manufacture, abrasives, terrazzo, filler, riprap, and other uses.

METALS

Iron Ore.—Production and shipments of iron ore came from two companies operating on the Gogebic Range in Iron County. Pickands Mather & Co. operated the Cary underground mine, and the Oglebay Norton Co. made shipments from stockpiles at the Montreal mine. All ore was direct-shipping grade. Average iron content, natural, of the 938,262 long tons of iron ore shipped was 54.31 percent.

Production of iron ore declined 62 percent, and shipments declined 10 percent. The Cary mine operated most of the year, two shifts per day, 4 days per week. The continued decline in production and shipments of iron ore over the past 2 years is a result of the demand by steel producers for higher quality iron ore. At the Montreal mine, shipments were made from stockpiles, and surface equipment from the underground mine was sold.

Shipments from the port of Ashland, Wis., began May 19 and ceased November 14. At Escanaba, Mich., the lake shipping season extended from April 19 to December 16.

TABLE 7.—Iron ore production and shipments

Year	Number of mines	Production (thousand long tons)	Shipments (thousand long tons)	Iron content of shipments natural (percent)
1959	4	944	701	53.39
1960	4	1,484	1,502	53.50
1961	2	1,129	1,122	53.61
1962	2	1,081	1,045	54.24
1963	2	413	938	54.31

Base prices per long ton for iron ores remained unchanged from those established April 1, 1962. Iron ore prices based on 51.50 percent natural iron for delivery at rail of vessel, lower Lake ports, follow: High Phosphorus and Mesabi Non-Bessemer, $10.65; Mesabi Bessemer, $10.80; Old Range Non-Bessemer, $10.90; and Old Range Bessemer, $11.05. The portions of these prices reflecting shipping costs from mines to lower Lake ports are not included in the total value of iron ore output of Wisconsin. Variation in grade from this base and differences in physical structure from established norms call for premiums or penalties.

Continued interest in the Black River Falls district was evidenced by application of the Jackson County Iron Co., a subsidiary of Inland

Steel Co., to the Wisconsin Public Service Commission for permission to divert water from the Black River for use in a taconite plant under consideration by the company.

Lead and Zinc.—Production of lead was 20 percent less in quantity and 6 percent less in value than in 1962. Zinc production increased 14 percent in quantity and value. The increase in lead and zinc prices during the last half of the year was responsible for an increase in exploration drilling activities in the southwest Wisconsin lead-zinc district. Three companies applied for assistance under the lead- and zinc-mining stabilization program. One application was certified for assistance.

A fire at the Shullsburg mine of the Mining and Smelting Division of The Eagle-Picher Co. on January 15, 1963, stopped operations of the mine and mill until July when the mill had been rehabilitated and a new inclined shaft was completed. The company opened the Booty-Thompson mine in April and trucked ore to their Graham mill near Galena, Ill.

The American Zinc, Lead and Smelting Co., Vinegar Hill Zinc Division, operated the Hancock-Winskell and the Thompson-Temperly mines—all ore being treated in the Vinegar Hill mill about 3.5 miles south of Shullsburg.

The Ivey Construction Co. operated a mine and mill at Linden, Wis., under lease from The Eagle-Picher Co.

The Grimes Mining Co. began operating a mine and mill on the Burnham property in December 1963.

TABLE 8.—Mine production of lead and zinc, in terms of recoverable metals

Year	Mines producing		Material treated		Lead		Zinc		Total value
	Lode	Tailings	Ore (short tons)	Tailings (short tons)	Short tons	Value	Short tons	Value	
1954–58 (average)	10	5	623,133	45,608	1,698	$493,473	18,293	$4,378,272	$4,871,745
1959	6	------	464,390	----------	745	171,350	11,635	2,676,050	2,847,400
1960	8	1	686,085	993	1,165	272,610	18,410	4,749,780	5,022,390
1961	9	1	465,407	99	680	140,080	13,865	3,188,950	3,329,030
1962	9	------	411,820	----------	1,394	256,496	13,292	3,057,160	3,313,656
1963	8	------	445,742	----------	1,116	241,056	15,114	3,476,220	3,717,276

TABLE 9.—Mine production of lead and zinc, by months, in terms of recoverable metals

(Short tons)

Month	Lead	Zinc	Month	Lead	Zinc
January	45	920	August	145	1,635
February	35	720	September	150	1,635
March	55	1,025	October	120	1,660
April	110	1,250	November	123	1,580
May	60	1,090	December	123	1,569
June	75	1,060			
July	75	970	Total	1,116	15,114

Piquette Mining and Milling Co. and the New Jersey Zinc Co. Elmo mine were idle during the year.

Average yearly weighted prices used to calculate values of lead and zinc in table 1 were 10.8 cents per pound for lead and 11.5 cents per pound for zinc, compared with 9.2 cents for lead and 11.5 cents for zinc in 1962.

REVIEW BY COUNTIES

Mineral production was reported from all of the 71 counties in the State. Total value of production increased in 34 counties and decreased in 37 counties compared with 1962. Seventeen counties had mineral production valued over $1 million. Sand and gravel production was reported in 67 counties and stone production in 45 counties. Table 10 shows the minerals produced in each county, although all counties are not discussed in the text.

Adams.—Arthur Overgaard Co. produced paving gravel from a stationary plant near Oxford.

Ashland.—Cold Spring Granite Co. produced dressed architectural granite from a quarry near Mellen. The county highway department produced sand and gravel for road base.

Barron.—Pioneer Sand & Gravel Co., Inc., Smith Bros., and the county highway department operated portable sand and gravel plants. Karshbaum-Yager operated a stationary sand and gravel plant near Chetek.

Bayfield.—U.S. Aggregate Co. produced crushed marble chips for terrazzo from a quarry near Grandview. The county highway department produced sand and gravel for road base with portable plants.

Brown.—Alvin Destree Sand & Gravel and Fred Kropp Sand & Gravel operated stationary sand and gravel plants near Green Bay. Schuster Construction Co. operated a stationary sand and gravel plant near Denmark. Daanen & Janssen, Vic Zeman, Soletski Sand and Gravel Co., and Koepke Sand & Gravel Co. operated portable sand and gravel plants. Daanen & Janssen operated portable plants in three quarries producing crushed limestone, including agricultural limestone. Scray Quarries near DePere produced limestone in rough blocks, sawed stone, and riprap. The Western Lime & Cement Co. produced quicklime and hydrated lime for chemical and other industrial uses. Duck Creek Brick Co. was inactive during the year. Hockers Bros. Brick & Tile Co. imports its brick and has ceased manufacturing brick from its own clay.

Buffalo.—The substantial increase in value in county production was due largely to an 83-percent increase in crushed limestone production. Mon-Arc Quarries, Inc., Arthur Overgaard, Inc., and J. Allan Wiles produced agricultural lime with portable plants. Herbert Tiffany, Jr., operated 11 quarries producing riprap and crushed limestone, including agricultural limestone. The county highway department produced sand for paving and fill with portable plants.

Calumet.—A decrease in value of sand and gravel of 31 percent from that of 1962 was reported. Sand and gravel was produced for building and paving with stationary plants by Arnold M. Ortlepp near Chilton and Quality Sand & Gravel Co. near Brillion. Sell Brothers Stone & Gravel Co. operated a portable plant near Stockbridge. The

TABLE 10.—Value of mineral production in Wisconsin, by counties

County	1962	1963	Minerals produced in 1963 in order of value
Adams	(1)	(1)	Sand and gravel.
Ashland	(1)	(1)	Stone, sand and gravel.
Barron	(1)	(1)	Sand and gravel.
Bayfield	(1)	(1)	Sand and gravel, stone.
Brown	$967,329	$787,275	Lime, sand and gravel, stone.
Buffalo	391,759	660,053	Stone, sand and gravel.
Burnett	78,175	70,528	Sand and gravel.
Calumet	262,433	187,545	Sand and gravel, stone.
Chippewa	(1)	190,872	Sand and gravel.
Clark	(1)	(1)	Sand and gravel, stone.
Columbia	(1)	(1)	Do.
Crawford	188,214	177,635	Stone, sand and gravel.
Dane	2,014,740	1,721,918	Sand and gravel, stone.
Dodge	1,175,149	1,065,670	Lime, sand and gravel, stone.
Door	331,457	195,985	Sand and gravel, stone.
Douglas	(1)	(1)	Lime, sand and gravel.
Dunn	(1)	107,667	Stone, clays, sand and gravel.
Eau Claire	(1)	(1)	Sand and gravel.
Florence	25,000	34,250	Do.
Fond du Lac	1,522,613	1,308,112	Stone, sand and gravel, lime, clays.
Forest	63,665	52,155	Sand and gravel.
Grant	680,632	689,306	Stone, sand and gravel, zinc.
Green	364,862	572,909	Sand and gravel, stone.
Green Lake	378,001	369,963	Sand and gravel.
Iowa	448,868	401,401	Stone, zinc.
Iron	(1)	(1)	Iron ore, sand and gravel.
Jackson	(1)	138,417	Sand and gravel.
Jefferson	301,760	227,647	Sand and gravel, stone.
Juneau	(1)	(1)	Stone, sand and gravel.
Kenosha	300,783	231,678	Sand and gravel.
Kewaunee	289,426	333,470	Do.
La Crosse	239,861	(1)	Sand and gravel, stone.
Lafayette	(1)	(1)	Zinc, lead, stone.
Langlade	188,555	244,967	Sand and gravel.
Lincoln	127,240	(1)	Sand and gravel, peat.
Manitowoc	(1)	(1)	Cement, sand and gravel, stone, lime, clays.
Marathon	2,029,726	2,700,862	Stone, sand and gravel.
Marinette	(1)	(1)	Do.
Marquette	219,850	(1)	Do.
Milwaukee	(1)	(1)	Cement, stone, sand and gravel.
Monroe	94,846	(1)	Stone.
Oconto	108,993	211,503	Sand and gravel, stone.
Oneida	206,418	219,916	Sand and gravel.
Outagamie	557,571	1,056,754	Sand and gravel, stone.
Ozaukee	386,131	382,512	Sand and gravel.
Pepin	4,543	1,362	Do.
Pierce	236,824	(1)	Sand and gravel, stone.
Polk	339,773	509,357	Stone, sand and gravel.
Portage	406,545	280,398	Sand and gravel, stone.
Price	10,393	59,666	Sand and gravel.
Racine	1,319,348	1,054,951	Stone, sand and gravel, clays.
Richland	(1)	(1)	Sand and gravel, stone.
Rock	1,823,585	1,732,190	Do.
Rusk	58,169	82,632	Sand and gravel.
St. Croix	449,716	404,690	Sand and gravel, stone.
Sauk	1,315,288	993,719	Stone, sand and gravel, abrasives.
Sawyer	63,364	63,741	Sand and gravel.
Shawano	205,049	278,229	Sand and gravel, stone.
Sheboygan	232,736	301,898	Do.
Taylor	421,386	389,597	Sand and gravel.
Trempealeau	(1)	(1)	Stone, sand and gravel.
Vernon	(1)	(1)	Do.
Vilas	169,070	137,438	Sand and gravel.
Walworth	401,880	372,510	Do.
Washburn	(1)	(1)	Do.
Washington	615,760	785,393	Sand and gravel, stone.
Waukesha	4,849,366	5,840,921	Sand and gravel, stone, peat.
Waupaca	(1)	(1)	Sand and gravel, stone, clays.
Waushara	(1)	(1)	Stone, abrasives.
Winnebago	1,681,908	1,556,054	Stone, sand and gravel.
Wood	(1)	(1)	Do.
Undistributed [2]	39,740,240	39,140,284	
Total	68,289,000	68,326,000	

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes some sand and gravel and stone that cannot be assigned to specific counties and values indicated by footnote 1.

county highway department produced gravel and crushed limestone for paving.

Chippewa.—The substantial increase in value of mineral production for the county was due to 311,400 tons of sand and gravel production reported by the county highway department. The Chippewa Sand & Gravel Co. operated a stationary sand and gravel plant near Chippewa Falls.

Clark.—Charles Marek & Son operated the Hatfield Sand & Gravel stationary plant near Merrillan which produced fill sand and gravel for fill and building. Sand and gravel also was produced by Carl Opelt with a stationary plant near Neillsville; by Plautz Bros., Inc., with a portable plant near Willard; and by the county highway department with portable plants. Ellis Quarries, Inc., produced rough structural sandstone.

Columbia.—Paving, molding, and glass sands were produced by Manley Sand Division, Martin Marietta Corp., at its stationary plant near Portage. James Sand & Gravel also produced molding sand at its portable plant near Doylestown. C. C. Linck, Inc., operated portable sand and gravel plants producing paving gravel near Portage and Columbus. Columbia Ready-Mix Co. and Wisconsin Dells Sand & Gravel also produced sand and gravel. Crushed limestone was produced by Dann & Wendt for agricultural use and by the county highway department for paving.

Crawford.—Three companies reported crushed limestone production from 10 quarries—Velmer Monroe near Steuben; Loren J. Slaght near Prairie du Chien, Gays Mills, Ferryville, and Eastman; and H. Turner & Sons from 4 quarries in the county. Sand and gravel was produced in stationary plants by Lakeside Sand & Gravel and Prairie Sand & Gravel, Inc., both near Prairie du Chien.

Dane.—Value of limestone production increased 1 percent, but value of sand and gravel decreased 22 percent. Sixty-one percent of the value of mineral production was sand and gravel. Leading producers of sand and gravel were Capitol Sand & Gravel Co., Hartland-Verona Gravel Co., Madison Sand & Gravel Co., Stewart Watson Construction Co., and Rein, Schultz, & Dahl, Inc. George M. Pendergast & Co., Inc., operated the stationary sand and gravel plant near Mt. Horeb formerly operated by General Silica Co., Inc. Harrison Engineering and Construction Corp. operated a portable sand and gravel plant near Sauk City formerly operated by Bushman Construction Co. Crushed limestone production was reported by 14 companies. Principal producers were Hammersley Stone Co., Inc., Madison Stone Co., Inc., and Wingra Stone Co. All crushed stone was from portable plants except that Madison Stone operated a stationary plant at its Ghost Hill quarry.

Dodge.—Hydrated lime was produced near Knowles by The Western Lime & Cement Co., which also produced crushed limestone. Mayville White Lime Works produced crushed limestone for metallurgical use, agriculture, and construction at its plant near Mayville. Sand and gravel was produced by Linck-Henes Construction Co., Inc., and C. C. Linck, Inc., with portable plants from 10 pits, and by Braun Construction Co., Inc., with a stationary plant near Lomira. The county highway department operated a stationary sand and gravel plant.

Door.—The decrease in total value of minerals produced in the county in 1963 is largely accounted for by a reduced production of sand and gravel. Sand and gravel was produced in stationary plants by Vernon E. Olson Excavating Co. and Howard Serrahn near Sturgeon Bay and by Hubert Charles in a plant near Brussels. Adamski-Fisher Quarry produced sawed limestone and house veneer near Sturgeon Bay. The county highway department produced sand and gravel and crushed limestone for road use.

Douglas.—Cutler-LaLiberte-McDougall Corp. produced quicklime for chemical and other industrial uses in its plant near Superior. Sand and gravel for paving was produced in portable plants by Otto Wiesner, Inc., the city of Superior, and the county highway department.

Dunn.—Increases in value of production over 1962 were reported for sand and gravel, limestone, and clays. Menomonie Brick Co. produced clay for brick manufacture. Arthur Overgaard, Inc., produced agricultural limestone from two quarries, and the Barron County Agriculture Department produced it from the Boyceville quarry. The county highway department produced sand and gravel for paving.

Fond du Lac.—Limestone accounted for 65 percent of the value of mineral production. Fifty-four percent of the limestone value was for sawed or broken architectural stone. Architectural stone was produced by El Dais Stone Co. near Oakfield; Fond du Lac Stone Co., Inc., at Fond du Lac; Hamilton Stone Co. near Fond du Lac; and the Oak Stone Co. near Oakfield. Crushed limestone was produced by several of these companies as well as by C. C. Linck, Inc., near Waupun; Nellis Limestone Quarry, Inc., near Ripon; and Waupun Ready-Mix, Inc., near Alto. The Western Lime & Cement Co. produced quicklime and hydrated lime and crushed limestone near Eden. The Oakfield Shale Brick & Tile Co. produced clay for brick near Oakfield. Gravel for paving was produced by Braun Construction Co., Inc., near Byron and Taycheedah; Lake View Sand & Gravel Co. near Fond du Lac; Cyril H. Simon near Taycheedah; and Koepke Sand & Gravel Co. near Ladoga. The county highway department produced gravel for fill.

Grant.—Joseph Grimes reopened the Burnham mine, idle since May 1961, under the name Grimes Mining Co., Inc. Access to the mine is by adit. Construction of a flotation mill was begun in July 1963. The mill had only a zinc circuit, because the ore contains very little lead. The mine and mill were placed in production in December. The mill has a capacity of about 100 tons per 24 hours, but is operated only two shifts. Piquette Mining and Milling Co. was idle all year. Crushed limestone was produced with portable plants by Becker & Tuckwood near Lancaster; Croft Lime & Gravel and Dell Needham near Fennimore; Loren J. Slaght from two quarries near Bloomington and one near Patch Grove; Leonard Staskal & Son near Hickory Grove; H. Turner & Sons near Cassville; G. A. Watson from three quarries; and George Wendtlandt from seven quarries. Becker & Tuckwood, Croft Lime & Gravel, Loren J. Slaght, Leonard Staskal & Son, and George Wendtlandt also produced agricultural limestone. Becker & Tuckwood and Dubuque Sand & Gravel Co. produced sand and gravel from stationary plants near Lancaster and Kieler, respectively.

Green.—The substantial increase in value of mineral production was caused principally by a substantial increase in value of sand and gravel production. Crushed limestone was produced with portable plants by P. W. Ryan Sons, Inc., from 12 quarries in the county; Bergen Rock & Lime Co. near Brooklyn; Rees Construction Co. near Monroe; and Ted Stauffacher near Monroe. All except P. W. Ryan Sons, Inc., produced agricultural limestone. Sand and gravel for building and paving was produced by Wm. J. Kennedy & Son, Inc., and John W. Dieckman from portable plants. John W. Dieckman purchased the Henry Altmann plant. Lyle T. Manley operated a stationary plant near Brownstown which produced foundry sand. The county highway department and the city of Monroe produced sand and gravel.

Green Lake.—Molding sand was produced in stationary plants by Clifford Chier Sand Co. near Green Lake, and by Chier St. Marie Sand Co. and F. B. Dubberstein & Sons, Inc., near Berlin. Sand and gravel for building, paving, and fill was produced by Kopplin & Kinas Co., Inc., Paul Polenska & Son, and the county highway department.

Iowa.—The Ivey Construction Co. leased the Linden mine and mill from The Eagle-Picher Co. and started production in April. Zinc ores were treated in the mill at the mine, which had been shut down since September 1960. Crushed limestone, including agricultural limestone, was produced with portable plants by Davis & Richardson, G. A. Watson, and George Wendtlandt. The county highway department produced crushed roadstone from three quarries.

Iron.—This county was first in value of mineral production in the State. The Cary underground mine, operated by Pickands Mather & Co., was the only active iron mine in the State. It operated 4 days per week, producing direct-shipping ore. Oglebay Norton Co. made shipments of direct-shipping iron ore from stockpiles at the Montreal mine which had been closed since August 1962. The county highway department contracted for production of gravel for road base.

Jackson.—Gravel for building, paving, and fill was produced by Laurence Murphy with a portable plant near Black River Falls and by H. T. Smith Sand & Gravel in a stationary plant near Hixton. The county highway department produced sand and gravel for building and paving with its own crews and by contract. The Jackson County Iron Co., a subsidiary of Inland Steel Co., applied to the Wisconsin Public Service Commission for permission to divert 2 cubic feet of water per second from the Black River to be used in a taconite plant under consideration by the company.

Jefferson.—Sand and gravel, principally for building and paving, was produced with portable plants by Wm. J. Kennedy & Son, Inc., near Jefferson; Rude Sand & Gravel near Oakland; Hausz Brothers, Inc., near Lake Mills; Arne Evensen Sand & Gravel Co. near Lake Mills; and Rein, Schultz & Dahl, Inc. The county highway department produced sand and gravel for paving and fill. Hausz Brothers, Inc., produced crushed limestone.

Juneau.—Arthur Overgaard Co. operated a stationary plant producing crushed limestone, including agricultural limestone. The county highway department produced sand and gravel for fill and crushed sandstone.

Kewaunee.—Sand and gravel was produced for building, paving, and fill in stationary plants by Schuster Construction Co. near Casco and Krueger Construction Co. near Algoma. The county highway department produced sand and gravel for paving.

La Crosse.—The value of mineral production in the county was substantially less than in 1962, principally due to a drop in the production of limestone. Sand and gravel was produced in two stationary plants near La Crosse by Kammel-Smith Sand & Gravel Co., Inc., and La Crosse Sand & Gravel, Inc. Arthur Overgaard, Inc., produced crushed limestone.

Lafayette.—A fire at the Shullsburg lead-zinc mine of The Eagle-Picher Co. on January 15 damaged the headframe and mill. Operations were halted until July 10. A new 2,225-foot truck haulage incline was driven to replace the vertical shaft used prior to the fire. The company also drove a 618-foot incline to the Booty-Thompson ore body between Benton and Shullsburg. Production started in April. The ore was trucked to the company's Graham mill near Galena, Ill., about 17 miles. The American Zinc, Lead & Smelting Co., Vinegar Hill Zinc Division, operated the Hancock-Winskell and the Thompson-Temperly mines. All ore was trucked to the mill south of Shullsburg. The company had four to six churn drills on exploration work during the year and did some long-hole and diamond drilling underground.

New Jersey Zinc Co. completed development of its ore body near Elmo, removed all equipment, and allowed the mine to flood. Plans for construction of a mill still are deferred. The company resumed exploration with one drill in the last part of the year.

Crushed limestone was produced in portable plants by Huggins & Son and Leo H. Klein near Belmont, Otto Jean near Darlington, McGettigan Lime Co. near Gratiot, G. A. Watson from two quarries, and George Wendtlandt from nine quarries.

Langlade.—Sand and gravel for building, paving, and fill was produced by Duffek Sand & Gravel, Inc., in a stationary plant near Antigo and by the county highway department with a portable plant. The increase in value over that of 1962 is largely due to a 64-percent increase in the quantity of sand and gravel produced by the highway department.

Lincoln.—Sand and gravel for building, paving, and fill was produced by Merrill Gravel & Construction Co. in a portable plant near Merrill and by the county highway department with a portable plant. Superior Brand Peats reported peat production in the county.

Manitowoc.—This county was third in the State in value of mineral production. Manitowoc Portland Cement Co. produced types I and II, general use and moderate heat portland cement, using local clay and limestone shipped by boat from Michigan. Most of the cement was shipped by truck in bulk. A new distribution terminal is being constructed with twin banks of six silos where two trucks can be loaded simultaneously in less than 5 minutes. Total capacity will be 150,000 barrels. Over 800,000 tons of sand and gravel for building, paving, and fill was produced in the county. Principal producers were August Ehnert & Sons, Inc., near Kiel; R. & J. Fricke Co., Manitowoc; Fred Radandt Sons near Manitowoc and Shoto; Evenson Bros. near

Valders; and the county highway department. Rockwell Lime Co. produced quicklime for chemical and other industrial use and hydrated lime for construction. Valders Lime & Stone Co. produced limestone rubble, rough block, sawed and cut stone, flagging, riprap, and crushed stone.

Marathon.—More than 97,000 cubic feet of dimension granite valued at almost $1.5 million, or 84 percent of the value of dimension granite produced in the State, came from the county. Leading producers of dimension granite were Anderson Bros. & Johnson Co., Cold Spring Granite Co., Lake Wausau Granite Co., Prehn Granite Quarries, Inc., and Wisconsin Quarries, Inc. Principal products were rough and dressed stone for monuments and mausoleums and dressed stone for architectural work. Tony Schilling Granite Pit and Phillip Knauf produced crushed granite.

Six companies and the county highway department produced sand and gravel. Principal producers were Heiser Ready Mix Co., Lotz Sand & Gravel Co., Riverside Gravel Co., and Rein, Schultz, & Dahl, Inc., all near Wausau, and the county highway department. Minnesota Mining & Manufacturing Co. produced material principally for roofing granules from its Greystone quarry and quartzite for abrasives, filter rock, and terrazzo chips from its Rib Mountain quarry. Ernest F. Liebe produced cut sandstone and flagging. Edward Nemke produced sawed sandstone.

Marinette.—The Ruberoid Co. produced basalt from its quarry near Pembine and used the material for manufacturing roofing granules. Rough and dressed granite monument stone was produced by Anderson Bros. & Johnson Co. Midwest Granite Co. produced dressed granite monument stone. Mason Sand & Trucking produced building sand in a stationary plant near Marinette. Soo Line Railroad Co. produced gravel for railroad ballast near Kremlin, and Koepke Sand & Gravel Co. operated a portable plant near Coleman which produced paving gravel. The county highway department produced sand and gravel for paving and fill.

Marquette.—Montello Granite Co. produced rough granite for monuments near Montello. The county highway department produced paving gravel.

Milwaukee.—The county was the fourth highest in value of mineral production in the State. Portland and masonry cements were produced by Marquette Cement Manufacturing Co. at a plant in Milwaukee using limestone from Michigan and shale from Illinois. Shipments were mostly in bulk by truck. Crushed limestone was produced in stationary plants by Consumers Company, Division of Vulcan Materials Company, near Hales Corners and by Franklin Stone Products, Inc., near Franklin. Gravel for fill was produced by Fink Sand & Gravel at a stationary plant near South Milwaukee. Wm. J. Kennedy & Son, Inc., produced sand and gravel for building and paving. Western Mineral Products Co. in its Milwaukee plant expanded perlite from New Mexico and vermiculite from Montana.

Monroe.—There was a substantial increase in the quantity of crushed limestone produced in the county. Crushed limestone was produced in portable plants by Otto Meyer and Schendel Brothers. Agricul-

tural limestone was produced by Arthur Overgaard, Inc., from 10 quarries and by Schultz Quarry Co. near Wilton.

Oconto.—The increase in mineral production value was largely due to increased sand and gravel production. Sand and gravel was produced near Little Suamico with a portable plant by Foster Construction Co., Inc., and near Gillett with a stationary plant by Gillett Cement Products, Inc. John Jaworski produced gravel near Sobieski. The county highway department produced paving gravel. Foster Construction Co., Inc., produced agricultural limestone near Gillett and concrete aggregate near Abrams.

Outagamie.—Over 1.2 million tons of sand and gravel, substantially more than in 1962, was largely responsible for the increase in mineral value for the county. Portable sand and gravel plants producing material for building, paving, and fill were operated by Fox Valley Construction Co. near Appleton, Koepke Sand & Gravel Co. near Freedom, Landwehr, Inc., at several locations, and M.R.K. Construction Co., Inc., near Seymour. A stationary plant operated by Murphy Construction Co. near Black Creek produced paving sand and gravel. The county highway department produced sand and gravel for paving and fill. Black Creek Limestone Co. produced crushed limestone, including agricultural limestone, in a stationary plant near Black Creek, and Landwehr, Inc., produced crushed limestone in a stationary plant near Mackville. Midwest Perlite Co. expanded perlite from Colorado for building plaster, insulation, concrete aggregate, and soil conditioning.

Ozaukee.—Sand and gravel, principally for building and paving, was produced in stationary plants by Muehlberg Gravel Co. near Port Washington; Cedarburg Sand & Gravel Co. and Richard Weber, Inc., near Grafton; and Rowe Sand & Gravel, Inc., at various locations. Milwaukee Gravel Products operated the former Ozaukee Sand and Gravel Co. equipment under lease. The county highway department and the city of Mequon produced sand and gravel.

Pierce.—A substantial increase in value of mineral production was due to increased production of industrial sands. The Guy-Berson Sand Co., Inc., of Jackson, Mich., purchased the Maiden Rock Silica Sand Co. and operated the plant under the name of Pepin Shore Silica Sand Co., Inc. Principal Products were glass, molding, blast, engine, and oil (hydrafrac) sands. Bay City Sand Co., Inc., produced molding, blast, filter, and engine sands. River Falls Sand & Gravel Co. and Rush River Sand & Gravel Co. produced building sand and gravel. Herbert Tiffany, Jr., produced crushed limestone from a quarry formerly operated by Sanders Stone & Lime Co.

Polk.—The increased mineral value for the county was due to increased production of stone and Government-and-contractor sand and gravel. Bryan Dresser Trap Rock, Inc., produced riprap, roadstone, and railroad ballast. The Polk County Agricultural Agency produced agricultural limestone. Sand and gravel for building and paving was produced by Atlas Gravel & Concrete Products Co. and Jorgenson Construction Co. near Luck, Bohn Sand & Gravel near Frederic, Ostermann Sand & Gravel, Inc., near Turtle Lake, and the county highway department.

Portage.—Sand and gravel was produced with stationary plants by F. F. Mengel Co. near Custer for building and paving and by Wimme Sand & Gravel near Stevens Point for building, paving, and railroad ballast. The county highway department produced paving gravel. Ellis Quarries, Inc., at Stevens Point produced rough stone and flagstone from a sandstone deposit. Caldwell's Dredging Co. produced marl for agricultural use.

Racine.—Consumers Company, Division of Vulcan Materials Company, produced crushed limestone for concrete in a stationary plant near Racine, and the county highway department produced limestone near Rochester. Stationary sand and gravel plants were operated by Hillside Sand Co., Inc., near Caledonia and J. W. Peters & Sons, Inc., near Burlington. Sand and gravel for paving was produced in portable plants by Morrow & Reesman and the county highway department. Union Grove Drain Tile Co. mined clay for heavy clay products

Rock.—Over 1.8 million tons of sand and gravel was produced in the county. Principal producers were Wm. J. Kennedy & Son, Inc.; Chicago, Milwaukee, St. Paul, & Pacific Railroad Co.; Janesville Sand & Gravel Co.; Lyle T. Manley Co.; and the county highway department. Crushed limestone was produced by nine companies. Principal uses were for concrete, roadstone, and agricultural limestone. Principal producers were Footville Lime & Rock Co., Little Limestone Co., P. W. Ryan Sons, Inc., and the county highway department.

St. Croix.—Sand and gravel was produced by Casey Gravel Works near New Richmond, Leary Construction Co., Inc., near River Falls, and the county highway department. Crushed limestone for concrete roadstone and agricultural limestone was produced by Leary Construction Co., Inc., near River Falls, Wilson Rock & Limestone Co. near Emerald and Wilson, and the county highway department.

Sauk.—The 24-percent decrease in value of mineral production was largely accounted for by the decrease in reported production of limestone and sand and gravel. Principal sandstone production was for railroad ballast by Foley Bros., Inc., and for refractory brick by General Refractories Co., and Harbison-Walker Refractories Co. Some sandstone was produced for concrete, filter, flagstone, and architectural purposes. Baraboo Quartzite Co., Inc., marketed quartzite tube-mill liners and grinding pebbles. Crushed limestone for concrete and agricultural limestone was produced by Frederic Bindl near Plain, Davis & Richardson at their Evans quarry, W. W. Deppe near Lake Delton, and Holtz & Schulenburg Lime Works near Loganville. Sand and gravel for building, paving, and fill was produced by Baraboo Concrete Co., Inc., and gravel for paving was produced by W. R. Du Bois & Son, Inc., both at Baraboo.

Shawano.—Sand and gravel was produced principally for building and paving in stationary plants by Ed J. Murphy Sand & Gravel Co. near Bonduel; Embarrass Sand & Gravel near Embarrass, and Mantin Bros. near Caroline. A. Riemer Sand & Gravel near Cecil and M. J. Zimmerman Construction Co. near Shawano produced sand and gravel with portable plants. The county highway department produced paving gravel, and the Shawano County Agricultural Commission produced crushed limestone, including agricultural limestone.

Sheboygan.—Stationary sand and gravel plants, principally for the production of building and paving material, were operated by Cascade Sand & Gravel Co. near Cascade, Crystal Lake Crushed Stone Co. near Elkhart Lake, and Plymouth Sand and Gravel, Inc., near Plymouth. A portable sand and gravel plant was operated by Schroeder Bros. Sand & Gravel Co. near Greenbush. The Sheboygan County Agricultural Department produced crushed limestone, including agricultural limestone.

Taylor.—Sand and gravel was produced for building and paving in portable plants near Medford by Francis Melvin and James Peterson Sons, Inc.; near Westboro by Zentner Bros. & Haenel; and by the county highway department.

Vernon.—Production of agricultural limestone in portable plants was reported by Ellefson Bros. near Viroqua and by Otto Novy near Hillsboro, who also added new equipment to his plant. The county highway department produced fill sand.

Vilas.—Sand and gravel, principally for building and paving, was produced by Trapp Bros. in a stationary plant near Arbor Vitae; Rein, Schultz & Dahl, Inc., in a portable plant near Eagle River; Ahl-Brook Co. in a portable plant near Sayner; and the county highway department in a portable plant.

Walworth.—Over 600,000 tons of sand and gravel, principally for building, paving, and fill, was produced by eight companies. Principal producers were Ernest Nobis near Fontana, B. R. Amon & Sons near Elkhorn, Mann Bros. Sand & Gravel, Inc., from several locations, and R. W. Miller & Sons, Inc., near Lake Geneva.

Washington.—Over 900,000 tons of sand and gravel, largely for building, paving, and fill, was produced by eight companies. Leading producers were Koepke Sand & Gravel Co. near Hartford, Milwaukee Gravel Products (formerly Ozaukee Sand & Gravel Co.) in a stationary plant near Colgate and a portable plant near Meeker, Reiske Sand & Gravel Corp. near Germantown, and Werner Johann Sand & Gravel near West Bend. The county highway department produced sand, gravel, and crushed limestone for building and paving.

Waukesha.—Value of mineral production was the second highest of all counties in the State. Over 5 million tons of sand and gravel and 900,000 tons of limestone were produced. Limestone production included 400,000 cubic feet of dimension stone, principally for architectural use as sawed stone, house veneer, cut stone, and flagging. Over 25 operators were engaged in dimension stone production, chiefly near Lannon and Sussex. Principal producers were Halquist Lannon Stone Co., Joecks Brothers Stone Co., Midwest Lannon Stone Co., Quality Limestone Products, Inc., Sussex Lannon Stone Corp., and Wislanco Lannon Stone Co., Inc. Principal crushed limestone producers were Halquist Lannon Stone Co., Quality Limestone Products, Inc., and Waukesha Lime & Stone Co., Inc.

Principal sand and gravel producers included Consumers Company, Division of Vulcan Materials Company, near Dousman, Jaeger Sand & Gravel Co., Inc., near New Berlin, Palmer Crushing Co. near Colgate, State Sand & Gravel Co. near Merton, Valley Sand & Gravel Co. near Muskego, and Hillview Sand & Gravel Co. near New Berlin. Peat was produced by Demilco, Inc., and H. Geipels Custom Soil, Inc.

Waupaca.—Sand and gravel was produced for paving and fill by C. H. Peters near Caledonia, Stilen's Sand & Gravel and Mantin Bros. near Clintonville, and the county highway department. Crushed limestone for concrete and agricultural limestone was produced by C. H. Peters, near Readfield and for paving by the county highway department. Clay was produced for brick by Hockers Brick Company near New London, and Caldwell's Dredging Co. produced marl for agricultural use.

Winnebago.—Over 900,000 tons of crushed limestone was produced for riprap, concrete and roadstone, agricultural limestone, and asphalt filler. Limestone producers were Badger Highways Co., Inc., near Menasha, Consumers Company, Division of Vulcan Materials Company, near Oshkosh, and Courtney & Plummer, Inc., near Neenah. Sand and gravel for building and paving was produced by Courtney & Plummer, Inc., Friedrich, Loots & Below, Inc., Schulz Sand & Gravel, Inc., and the county highway department.

Wood.—Dimension sandstone was produced by Ellis Quarries, Inc., Klesmith Stone Co., and Tony Schmick. The county highway department produced sand and gravel and crushed granite for paving.

The Mineral Industry of Wyoming

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Wyoming for collecting information on all minerals except fuels.

By F. D. Everett [1]

MINERAL PRODUCTION in Wyoming reached a record value in 1963, an increase of 9 percent over that of 1962. Mineral fuels contributed 82 percent of the total value, nonmetals 9 percent, and metals 9 percent.

Petroleum output accounted for 72 percent of the total value, followed, in order of value, by natural gas, uranium ore, sodium carbonate, iron ore, natural gas liquids, clays (principally bentonite), coal, sand and gravel, cement, stone, phosphate rock, vanadium, lime, gypsum, gem stones, pumice, sodium sulfate, vermiculite, gold, and

TABLE 1.—Mineral production in Wyoming [1]

Mineral	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate ---- short tons, gross weight	1	(2)	(3)	(3)
Clays ---- thousand short tons	1,141	$11,138	1,113	$11,387
Coal (bituminous) ---- do	2,569	8,198	3,124	9,922
Gem stones		(4) 85		(4) 110
Gold (recoverable content of ores, etc.) ---- troy ounces			4	(3)
Iron ore (usable) ---- thousand long tons, gross weight	739	6,441	1,604	17,504
Natural gas ---- million cubic feet	204,996	29,929	209,060	29,687
Natural gas liquids:				
LP gases ---- thousand gallons	149,438	5,762	150,437	6,203
Natural gasoline and cycle products ---- do	78,780	4,935	86,014	5,523
Petroleum (crude) ---- thousand 42-gallon barrels	135,847	338,259	[5] 144,407	[5] 361,018
Pumice ---- thousand short tons	42	41	(3)	(3)
Sand and gravel ---- do	7,769	8,104	7,901	7,874
Stone ---- do	1,755	3,054	1,940	2,991
Uranium ore ---- short tons	1,301,784	25,715	1,475,070	27,243
Vanadium ---- do	(3)	442	(3)	435
Value of items that cannot be disclosed: Cement, gypsum, lime, phosphate rock, sodium carbonate, sodium sulfate, vermiculite, and values indicated by footnote 3		20,467		24,736
Total		[6] 462,570		504,633

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Less than $500.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Weight not recorded.
[5] Preliminary figure.
[6] Revised figure.

[1] Mining engineer, Bureau of Mines, Denver, Colo.

beryllium concentrate. Significant advances in value of production were recorded for petroleum, iron ore, sodium carbonate, coal, uranium ore, and natural gas liquids. Minor production declines were noted for natural gas, sand and gravel, stone, pumice, vanadium, and sodium sulfate.

A constant-dollar series has been prepared in which the bias caused by price level variations is reduced, thus showing more nearly the real change in the annual value of mineral production. The series is constructed by summing the constant-dollar value of several mineral groups. These groups were converted to 1957–59 constant dollars by dividing the group current-dollar value by the appropriate group implicit price deflator.

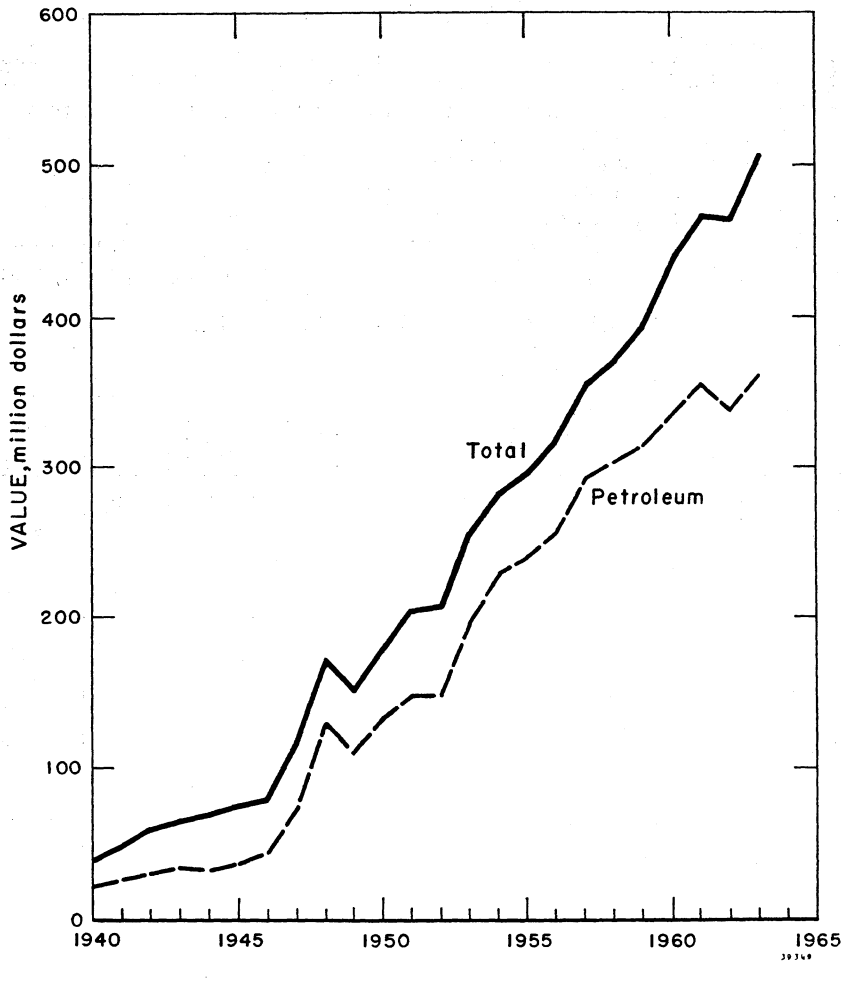


FIGURE 1.—Value of petroleum, and total value of mineral production in Wyoming, 1940–63.

TABLE 2.—Value of mineral production in 1957–59 constant dollars

(Thousands)

Year	Value	Year	Value
1952	$247,127	1958	$369,812
1953	289,508	1959	399,274
1954	308,805	1960	439,685
1955	325,666	1961	461,421
1956	342,093	1962	450,680
1957	349,036	1963	489,240

Noteworthy mineral-industry developments included completion of the first unit of the coal-based powerplant of Utah Power & Light Co. near Kemmerer; Amax Petroleum Corp. completed a natural gas processing plant at the Boone Dome field, Natrona County; and Atlantic Refining Co. completed a similar plant at the Riverton Dome field, Fremont County.

Government Programs.—Research programs on Wyoming resources at the Bureau of Mines Laramie Petroleum Research Center included areal variation in reservoir-oil characteristics, Newcastle sandstone, Greater Clareton area; laboratory predictions of water sensitivity compared with field observations of well drainage, Patrick Draw field; effect of clay hydration on the relative permeability to gas in water-sensitive sands; crude-oil analyses as a guide to asphalt potential; sulfur in petroleum; physical structure of Green River oil shale; and bacterial conversion of oil shale.

Several reports on mineral resources in Wyoming were published by the Bureau of Mines and the Federal Geological Survey.[2]

According to the Bureau of Land Management,[3] Wyoming received $14.4 million from the U.S. Treasury—the largest payment made to any of 23 States—for bonuses, royalties, and rentals from leasing on Federal lands during 1963. All States except Alaska received 37.5 percent of the Federal mineral revenues from lands within their borders. The Reclamation Fund received 52.5 percent, and the Treasury General Fund received 10 percent of the total revenue collected.

[2] Brobst, D. A., and J. B. Epstein. Geology of the Fanny Peak Quadrangle, Wyoming-South Dakota. Geol. Survey Bull. 1063–I, 1963. pp. 323–377.
Cuppels, N. P. Geology of the Clifton Quadrangle, Wyoming and South Dakota. Geol. Survey Bull. 1063–H, 1963, pp. 271–321.
Davis, R. E., and G. A. Izett. Geology and Uranium Deposits of the Strawberry Hill Quadrangle, Crook County, Wyo. Geol. Survey Bull. 1127, 1962, 87 pp.
Everett, F. D. Mining Practices at Four Uranium Properties in the Gas Hills, Wyo. BuMines Inf. Circ. 8151, 1963, 83 pp.
Mapel, W. J., and C. L. Pillmore. Geology of the Inyan Kara Mountain Quadrangle, Crook and Weston Counties, Wyo. Geol. Survey Bull. 1121–M, 1963, 56 pp.
Mapel, W. J., and C. L. Pillmore. Geology of the Newcastle Area, Weston County, Wyo. Geol. Survey Bull. 1141–N, 1963, 85 pp.
McGrew, L. W. Geology of the Fort Laramie Area, Platte and Goshen Counties, Wyo. Geol. Survey Bull. 1141–F, 1963, 39 pp.
Pillmore, C. L., and W. J. Mapel. Geology of the Nefsy Divide Quadrangle, Crook County, Wyo. Geol. Survey Bull. 1121–E, 1963, 52 pp.
Robinove, C. J., and T. R. Cummings. Ground-Water Resources and Geology of the Lyman-Mountain View Area, Uinta County, Wyo. Geol. Survey Water Supply Paper 1669–E, 1963, 43 pp.
Sheldon, R. P. Physical Stratigraphy and Mineral Resources of Permian Rocks in Western Wyoming. Geol. Survey Prof. Paper 313–B, 1963, pp. 49–273.
Smith, J. W., L. G. Trudell, and K. E. Stanfield. Comparison of Oil Yields From Core and Drill-Cutting Sampling of Green River Oil Shales. BuMines Rept. of Inv. 6299, 1963, 35 pp.

[3] Bureau of Land Management. U.S. Department of the Interior. News release, Feb. 11, 1964.

Water.—The Federal Bureau of Mines conducted a survey of water utilization in the mineral industry in 1963 for water use in 1962; results, according to respondents of the survey, are summarized in table 3. Results of water use in the petroleum industry are tabulated in table 4.

TABLE 3.—Water used in the mineral industry in 1962 by type of operations

(Million gallons)

Type of operation [1]	New water	Recirculated water	Total water used	Discharged water	Consumed water	Gallons of new water per dollar value of production
Quarries and mills	50	1	51	48	2	16.52
Coal mines	(2)		(2)	(2)		15.01
Metal mines and mills	2,021	8,950	10,971	827	1,194	63.88
Nonmetal mines and mills	2,062	6,317	8,379	1,583	479	74.65
Sand and gravel operations	443	132	575	408	35	54.84
Natural gas processing plants	722	2,745	3,467	144	578	40.10
Total	5,298	18,145	23,443	3,010	2,288	
Oil- and natural-gas-well drilling			260			
Secondary-recovery operations			8,318			
Total			8,578			
Grand total			32,021			

[1] Water survey did not include cement plants, lime plants, metal smelters, metal refineries, petroleum refineries, natural-brine operations, sand and gravel operations using suction dredges without preparation plants, stockpile operations, and assessment work operations.
[2] Less than 1,000,000 gallons.

TABLE 4.—Water used for oil and natural gas wells drilled in 1962, by counties

County	Number of wells	Total footage drilled (feet)	Fresh water used	Saline water used	Other water used	Total water used	Total barrels per foot
			(42-gallon barrels)				
Albany	2	16,075	36,230			36,230	2.26
Big Horn	20	61,959	143,745			143,745	2.32
Campbell	151	1,172,933	1,196,392			1,196,392	1.02
Carbon	17	87,776	23,700			23,700	.27
Converse	32	184,466	256,408			256,408	1.39
Crook	82	454,240	517,834			517,834	1.14
Fremont	46	299,058	765,588			765,588	2.56
Goshen	1	1,670	2,321			2,321	1.39
Hot Springs	15	64,187	78,487	30,632		109,119	1.70
Johnson	24	85,795	165,584			165,584	1.93
Laramie	6	46,799	44,459			44,459	.95
Lincoln	17	100,340	139,473			139,473	1.39
Natrona	93	226,757	564,625			564,625	2.49
Niobrara	17	96,330	115,596			115,596	1.20
Park	45	203,125	463,125			463,125	2.28
Platte	2	10,160	14,122			14,122	1.39
Sheridan	7	44,948	62,478			62,478	1.39
Sublette	78	398,967	441,623		15,189	456,812	1.15
Sweetwater	96	575,907	387,837		487,542	875,379	1.52
Teton	4	18,955	26,347			26,347	1.39
Uinta	3	21,547	29,950			29,950	1.39
Washakie	16	64,690	124,205			124,205	1.92
Weston	45	226,252	65,613			65,613	.29
Total	819	4,462,936	5,665,742	30,632	502,731	6,199,105	[1] 1.39

[1] Average.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral-fuels production increased in value from $387 million in 1962 to $412 million in 1963. Petroleum dominated the fuels, followed, according to value, by natural gas, natural gas liquids, and coal.

Coal (Bituminous).—Coal production continued to increase from a low reached in 1958; the value of the 1963 output was 21 percent more than that of 1962. The increases were attributed to the new Sorensen mine of The Kemmerer Coal Co., Dave Johnston mine of the Pacific Power & Light Co., Rosebud and Rosebud No. 2 mines of the Rosebud Coal Sales Co., Big Horn mine of the Big Horn Coal Co., and the Wyodak mine of the Wyodak Resources Development Corp. Significant decreases in output were reported for the Elkol and Brilliant No. 8 mines of The Kemmerer Coal Co., Hanna Basin mine of the Hanna Basin Coal Co., and Rainbow No. 7 mine of the Gunn-Quealy Coal Co. Production was reported from 22 mines; the output of 5 mines, being less than 1,000 tons for the year, was not included in the production tabulations. Major production came from the following strip operations in the order of quantity: Dave Johnston, Wyodak, Rosebud and Rosebud No. 2, Sorensen, Big Horn, and Elkol. Most of the output from these operations was used in coal-based electric powerplants in Wyoming and neighboring States.

TABLE 5.—Coal (bituminous) production by counties

(Excludes mines producing less than 1,000 short tons)

County	1962		1963	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Campbell	482,781	$1.30	495,886	$1.31
Carbon	462,866	2.45	531,021	3.96
Converse	766,314	4.02	[2] 1,109,322	[2] 3.44
Hot Springs	11,449	8.78	(2)	(2)
Lincoln	333,486	3.27	612,053	3.45
Sheridan	356,636	3.36	375,823	3.32
Sweetwater	155,192	6.21	(2)	(2)
Total	2,568,724	3.20	3,124,105	3.18

[1] Value received or charged for coal f.o.b. mine, including selling cost. (Includes a value for coal not sold but used by producer, such as mine fuel and coal coked, as estimated by producer at average prices that might have been received if such coal had been sold commercially.)
[2] Production of Hot Springs and Sweetwater Counties combined with Converse County to avoid disclosing individual company confidential data.

The Kemmerer Coal Co. planned to close the Brilliant No. 8 underground coal mine near Kemmerer early in 1964 because of diminishing markets and unfavorable economics. This mine had a long history of important production.

Utah Power & Light Co. completed the first of a planned three-stage powerplant near Kemmerer providing for a 150,000-kilowatt unit. When operated at capacity, this unit would require between 600,000 and 700,000 tons of coal per year. Coal for the plant was contracted to The Kemmerer Coal Co., which had developed the new

Sorensen strip mine adjacent to the company Elkol strip mine. Morrison-Knudsen Co., Inc., stripped and mined the coal under contract to The Kemmerer Coal Co. Eventual capacity of this plant was to be 500,000 kilowatts, requiring about 2 million tons of coal per year.[4]

Near Rock Springs, Gunn-Quealy Coal Co., an affiliate of The Kemmerer Coal Co., began constructing a plant to produce coke. The plant featured a rotating hearth, designed for bituminous coal mined near Rock Springs. Market for the coke included the processing of elemental phosphorus by the electric-furnace method at a plant in Idaho.

The FMC Corp.-United States Steel Corp. experimental coke plant near Kemmerer was placed on standby in July. Process tests at the plant reportedly demonstrated that metallurgical coke could be produced from subbituminous coals. The process provided an excellent potential for needed coke in areas of the world where little or no coking-coal reserves exist. United States Steel Corp. tested the coke made from the subbituminous coals near Kemmerer in iron blast furnaces; FMC Corp. also tested the coke in electric furnaces for producing elemental phosphorus in Idaho.

Near Glenrock, Pacific Power & Light Co. continued constructing its third unit powerplant to be completed by June 1964. This unit, a 200,000-kilowatt steam-electric plant addition to two previously constructed units, was to double the total capacity to 400,000 kilowatts. The company also began constructing three transmission lines to bolster the power supply in Wyoming: A 230,000-volt line from Rock Springs to Flaming Gorge damsite, a 115,000-volt line from Muddy Ridge near Riverton to Thermopolis, and a 115,000-volt line from the new Frannie substation to Garland and the Oregon basin. Pacific Power & Light Co. had invested more than $66 million in powerplant and coal-mine facilities in Wyoming by July 1964.

Natural Gas.—Although natural gas production increased 2 percent, the value decreased 1 percent in 1963. The reported value of natural gas comprised 6 percent of the value of total mineral production. Four natural gas discovery wells and 49 development wells were completed in 1963. Reserves[5] as of January 1, 1964, were 4,025 billion cubic feet, 200 billion cubic feet less than in 1962. Output, with an average value of $0.1245 per thousand cubic feet, came from 578 wells in Big Horn, Campbell, Carbon, Converse, Crook, Fremont, Hot Springs, Johnson, Laramie, Natrona, Niobrara, Park, Sublette, Sweetwater, Uinta, Washakie, and Weston Counties. Sublette and Sweetwater Counties led the State in natural gas development.

Three new plants began processing natural gas in 1963. Amax Petroleum Corp. processed natural gas in a new plant in Natrona County, recovering propane and butane; Atlantic Refining Co. recovered natural gasoline in a new plant in Fremont County; and California Oil

[4] Coal Age. Subbituminous for Power—The Sorensen Story. V. 68, No. 9, September 1963, pp. 74–81.
[5] Oil and Gas Journal. Crude Reesrves Dip, Gas, Gas-Liquids Up. V. 62, No. 4, Jan. 27, 1964, pp. 157–158.

Co. completed a two-unit plant at the Birch Creek field near Big Piney, Sublette County.

Colorado Interstate Gas Co. was planning to construct a $6 million ammonia plant to produce nitrogen fertilizers and industrial products on the Dan Rees ranch west of Cheyenne. The plant was to be operated by Wycon Chemical Co., a newly created subsidiary of Colorado Oil & Gas Corp. of Denver, Colo., of which, in turn, 95 percent was owned by Colorado Interstate Gas Co. Construction, reportedly, was to start in May 1964; completion was scheduled for early 1965. Plans called for yearly production of 18,000 tons of anhydrous ammonia and 33,000 tons of ammonium nitrate. For the process the plant was to require about 5 million cubic feet of natural gas daily.

Natural Gas Liquids.—The upward trend in the processing of natural gas continued with the number of plants recovering natural gasoline, propane, and butane increasing from 23 to 25 in 1963. Capacity of plants was about 760 million cubic feet of gas per day, although the average throughput was 593 million cubic feet per day. The quantity of natural gasoline recovered in 1963 increased 9 percent, and LP gases—butane, propane, and mixed gases—increased 1 percent.

Pan American Petroleum Corp. began improving facilities at its 66-million-cubic-feet-per-day Beaver Creek plant in Fremont County. The plant improvement, scheduled for completion by late 1964, was to increase capacity to 81 million cubic feet of gas per day. An additional 1,800 gallons of natural gasoline and 55 long tons of sulfur were to be recovered.

Petroleum.—According to preliminary figures, production of crude petroleum in 1963 increased 6 percent. Production came from 7,611 wells in 286 fields, with 31 fields having an annual output of more than 1 million barrels. Exploration drilling of 326 wells, 53 less than in 1962, resulted in 25 discoveries or new pay zones, 21 less than in 1962. Twenty-one of the exploration wells discovered were crude petroleum; four were natural gas. Development drilling increased from 440 wells in 1962 to 558 wells in 1963, resulting in 308 crude-oil-well and 49 natural-gas-well completions. Fifty-one percent of the total drilling in Wyoming was in the Powder River basin, which accounted for 56 percent of the exploratory work and 59 percent of the discoveries. The Green River basin accounted for 27 percent of the overall drilling; the Big Horn River basin for 12 percent; the Wind River basin for 7 percent; and the Hanna, Laramie, and Denver-Julesburg basins for 3 percent. Preliminary accounting of fields yielding more than 5 million barrels of crude oil included Elk Basin, Park County, 19.4 million barrels; Hamilton Dome, Hot Springs County, 10.7 million; Salt Creek, Natrona County, 8.6 million; Oregon Basin, Park County, 6.5 million, and Grass Creek, Hot Springs County, 5.3 million. The average value of crude oil at or delivered to pipeline entry was $2.499 per barrel.

Refinery output from nine plants in Wyoming was 45.7 million barrels, an increase of 1 percent compared with that of 1962.

TABLE 6.—Wildcat- and development-well completions in 1963, by counties

County	Oil	Gas	Dry	Total	Footage
Wildcat:					
Albany			1	1	3,100
Big Horn	1		16	17	48,800
Campbell	7		63	70	620,700
Carbon	1	1	18	20	94,000
Converse			6	6	39,100
Crook	4		32	36	199,800
Fremont		2	18	20	96,400
Goshen			2	2	11,600
Hot Springs			8	8	33,600
Johnson			12	12	59,800
Laramie			6	6	54,800
Lincoln			4	4	33,100
Natrona	2		20	22	83,900
Niobrara			10	10	38,400
Park			11	11	71,100
Sheridan			3	3	30,700
Sublette	2		8	10	45,300
Sweetwater		1	29	30	175,700
Washakie	1		6	7	30,700
Weston	3		28	31	148,600
Total	21	4	301	326	1,919,200
Development:					
Albany			1	1	9,600
Big Horn	2	1	4	7	23,900
Campbell	52	1	41	94	800,600
Carbon	8		4	12	63,800
Converse	10	2	11	23	117,900
Crook	16		25	41	228,800
Fremont	15	8	14	37	198,800
Hot Springs	15		8	23	89,300
Johnson	2		3	5	36,500
Laramie	3		5	8	59,600
Lincoln	12	2	2	[1] 17	50,200
Natrona	49	1	12	62	153,500
Niobrara	4	1	4	9	30,600
Park	15	2	5	22	88,300
Sheridan			1	1	5,100
Sublette	68	21	25	[2] 117	399,500
Sweetwater	12	10	16	38	197,400
Uinta			1	1	900
Washakie			1	1	8,700
Weston	25		14	39	112,400
Total	308	49	197	[3] 558	2,675,400
Total all drilling	329	53	498	[3] 884	4,594,600

[1] Includes 1 service well.
[2] Includes 3 service wells.
[3] Includes 4 service wells.

Source: Oil and Gas Journal.

American Oil Co. at Casper had the largest recovery with 10.3 million barrels; Sinclair Refining Co. at Sinclair followed with 9.1 million; Texaco Inc., at Casper, 8.7 million; Frontier Refining Co. at Cheyenne, 5.4 million; Mobile Oil Co. Division, Socony Mobile Oil Co., Inc., at Casper, 4.6 million; Husky Oil Co. at Cody, 3.1 million; Empire State Oil Co. at Thermopolis, 2.6 million; Sioux Oil Co. at Newcastle, 1.8 million; and C & H Refinery at Lusk, 19,600 barrels.

Modernization of the 40-year-old Sinclair refinery was more than 50 percent complete by yearend. The first phase of the multimillion-dollar program included a new catalytic reformer, a distillate hydrotreating unit, and a polymerization unit. The second phase of the program, to begin in January 1964, consisted of replacing obsolete

stills. Included in the program were a sulfur recovery plant and installation of pushbutton controls for blending gasoline and distillates.

Sioux Oil Co. increased crude throughput capacity from 6,000 to 7,000 barrels per stream day. New construction included a thermocatalytic cracker, a hydrofluoric acid alkylation unit, and a gas-concentration unit.

Cochran Chemical Co. of Denver, Colo., announced a new chemical plant was to be constructed at Osage in Weston County to mix and compound solvents and chemicals for treating oil and water for the petroleum industry. The plant was to have facilities for treating 14 different grades of oil.

Sinclair Pipe Line Co. and Skelly Pipe Line Co. completed the 10,000-barrel-per-day, 204-mile, 6-inch Medicine Bow pipeline between Sinclair and Denver, Colo. The pipeline was to move gasoline, kerosine, and heating oils from the Sinclair refinery to the Denver area.

Continental Pipeline Co. completed a 330-mile, petroleum-products pipeline from Billings, Mont., to Sinclair. The pipeline passed through Casper, where connections were made with the Wyco pipeline to Denver. Connected with the Pioneer pipeline at Sinclair, the new line provided a means for the Continental Oil Co. products to be moved to the Salt Lake City, Utah, area.

The Federal Power Commission gave approval to Montana-Dakota Utilities Co. for a 98.5-mile, 12-inch pipeline from the Riverton field to Worland.

TABLE 7.—Crude petroleum production, by counties[1]

(Thousand barrels)

County	1962	1963[2]	Principal fields in 1963 in order of production
Albany	729	837	Quealy Dome.
Big Horn	10,354	10,194	Garland, Byron, Bonanza, Sage Creek.
Campbell	5,277	8,111	Timber Creek, Raven Creek, Rozet.
Carbon	3,162	3,574	Wertz, Rock River.
Converse	3,756	4,034	Glenrock South, Big Muddy.
Crook	5,915	6,239	Coyote Creek, Donkey Creek.
Fremont	12,834	12,655	Beaver Creek, Steamboat Butte, Winkleman Dome, Big Sand Draw.
Goshen	11	9	Torrington.
Hot Springs	20,817	23,649	Hamilton Dome, Grass Creek, Little Buffalo, Murphy Dome.
Johnson	6,249	6,465	Sussex, North Fork, Meadow Creek.
Laramie	343	435	Horse Creek.
Natrona	12,455	14,381	Salt Creek, Grieve Unit.
Niobrara	1,117	976	Lance Creek, Little Buck Creek.
Park	34,245	33,975	Elk Basin, Oregon Basin, Frannie, Fourbear.
Sheridan	700	607	Ash Creek.
Sublette	2,212	4,248	Birch Creek, Green River Bend, Big Piney Shallow, LaBarge.
Sweetwater	9,711	[3]8,684	Lost Soldier, Patrick Draw, Arch Unit.
Uinta	[3]87	4	Spring Valley.
Washakie	2,272	2,105	Cottonwood Creek, Worland, Hidden Dome, Slick Creek.
Weston	3,601	3,225	Fiddler Creek, Clareton, Osage.
Total	135,847	144,407	

[1] Based on Rocky Mountain Oil Reporter data adjusted to Bureau of Mines total.
[2] Preliminary figures.
[3] Includes data for Church Buttes field.

TABLE 8.—Oil and gas discoveries in 1963

County and field	Well	Operator	Location			Producing formation	Gross producing interval (feet)	Total depth (feet)	Initial production		Completion date	Remarks
			Section	Township	Range				Barrels oil per day	Thousand cubic feet of gas per day		
Big Horn County:												
West Bonanza.	No. 1 Government.	Stanley Walters	17	49 N	91 W	Mowry	1,370–1,400	1,840	7		Mar. 18	Pumped. Old well, new zone.
Campbell County:												
Am-Kirk	No. 3-D Federal	Ambassador Oil Corp.	5	46 N	70 W	Dakota	8,704–8,726	10,276	360		Feb. 8	Flowed. Old well, new zone.
Bishop Ranch	No. 1 Federal-Aztec	Kewanee Oil Co	23	48 N	70 W	Minnelusa	9,538–9,552	9,727	185		June 17	Pumped.
Timber Creek	No. 1 Toro	True Oil Co	7	49 N	70 W	Muddy	7,612–7,640	9,431	160		Mar. 14	Pumped. Old well, new zone.
Northwest Timber Creek.	No. 1 Baumfalk	Farmers Union Central Exchange.	1	49 N	71 W	Minnelusa	9,544–9,562	9,718	111		Feb. 19	Pumped.
Pleasant Valley	No. 1-A Heptner	True Oil Co	31	51 N	69 W	do	8,150–8,186	8,260	230		Feb. 4	Do.
York	No. 1 Brehm-Government.	Kewanee Oil Co	32	54 N	69 W	do	7,238–7,262	7,450	68		June 17	Do.
Soda Well	No. 1 Larrechea	Superior Oil Co	33	54 N	70 W	do	7,331–7,334	7,526	138		Oct. 14	Do.
2-V Creek	No. 1 Lucas	Union Texas Petroleum Co.	29	55 N	70 W	Muddy	5,770–5,787	7,588	207		Sept. 23	Do.
Rockypoint	No. 2-NW 32	McCulloch Oil Corp. of Calif.	34	57 N	69 W	do	3,710–3,752	5,601		4,500	Apr. 27	Flowed. Old well, new zone.
Carbon County:												
Robbers Gulch	No. 1 HOC-State	True Oil Co	18	14 N	91 W	Mesaverde	6,867–6,874 6,962–6,964	7,348		10,000	Aug. 8[1]	Flowed (shut-in).
Dutton Creek	No. 1 Cooper Estate.	Philip T. Sharples	25	19 N	78 W	Muddy	5,225–5,240	6,162	50		Aug. 5	Pumped.
Crook County:												
Slattery	No. A-14 Burrows	True Oil Co	30	49 N	68 W	Minnelusa	8,066–8,080	8,188	55		May 18	Pumped. Old well, new zone.
Minnelusa Discovery.	No. 1 Federal-Crook.	Sinclair Oil & Gas Co	2	51 N	68 W	do	6,937–6,963	7,112	134		July 22	Pumped.
Miller Creek	No. 1 Forney	Petroleum, Inc	20	51 N	68 W	Muddy	5,841–5,845	7,764	124	23	June 29	Do.

West Semlek	No. 21-1 Heath-Government.	Amax Petroleum Corp.	21	52 N	68 W	Minnelusa	7,277-7,300	7,480	170		Sept. 25	Do.
Driscoll Creek	No. 1-24-30 Gentry.	Mule Creek Oil Co	30	56 N	68 W	do	5,262-5,272	5,304	343		Feb. 8	Do.
Fremont County:												
Pavillion	No. 23-2 Shell-Government.	Shell Oil Co	2	3 N	2 E	Wind River	2,460-2,770	5,200		2,300	Dec. 6 [1]	Flowed. Old well, new zone.
Wind River Discovery.	No. 1 Government-Ocean Lake.	Atlantic Refining Co	9	3 N	3 E	do	2,321-3,182	6,000		No gauge.	June 11	Gas well.
Hawkins Draw	No. 1 Hawkins Draw.	Colorado Oil & Gas Corp.	18	35 N	92 W	Basal Lance	4,929-4,948	8,960		3,500	Dec. 11 [1]	Flowed
Hot Springs County: Prospect Creek.	No. 1 Skelton-State.	Chandler & Simpson	23	45 N	100 W	Curtis	4,563	4,750	50		Oct. 8	Pumped.
Natrona County: Government Bridge.	No. 1 Trigg-Government.	Ferguson-Bosworth	20	31 N	82 W	Muddy	4,976-4,978, 5,016-5,026.	5,306	100		Apr. 9	Pumped. Old Well, new zone.
Tipps	No. 2-24 Government.	Tipps Drilling	24	31 N	83 W	Lakota	5,408-5,414	5,420	250		Jan. 4	Pumped.
Sublette County: Green River Bend	No. 41-31 GRBU	BelcoPetroleum Corp.	31	27 N	112 W	Basal Wasatch.	2,637	2,918	205		Nov. 6	Flowed. Old well, new zone.
McDonald Draw Unit.	No. 9 MCDU	do	32	28 N	112 W	Tertiary	3,211-3,213	3,555	378		May 29	Flowed.
Sweetwater County: Massacre Hills	No. 1 Unit	Pan American Petroleum Corp.	26	17 N	108 W	Rock Springs.	9,486-9,492, 9,510-9,535.	12,016	33	167	Sept. 19 [1]	Flowed (shut-in).
Hallville	No. 1 Husky-State.	Chandler & Simpson	16	19 N	100 W	Almond	1,303-1,305	5,135	43		Dec. 27 [1]	Pumped.
Point of Rocks	No. 44-25 UPRR	Union Pacific Railroad Co.	25	20 N	101 W	Blair	3,446-3,457	3,466		2,069	Sept. 27	Flowed.
Washakie County: Middle Dome.	No. 1 Government.	R. J. Abbey	22	48 N	90 W	Tensleep	2,088-2,100	2,170	50		Nov. 15	Pumped.
Weston County: Shurley	No. 2 Government-McArthur.	E. L. K. Oil	24	42 N	65 W	Wall Creek	5,140-5,166	5,220	70		Jan. 17	Do.
South Coyote Creek.	No. 1 Mohawk-Federal.	Stuarco Oil Co., Inc., and Tenneco Corp.	23	48 N	68 W	Dakota	6,800-6,810	6,932	273		Sept. 1	Do.
South Coyote Creek.	No. 1 Paul L. Baker.	Tenneco Corp	23	48 N	68 W	Turner	5,441-5,446	6,830	111		Oct. 8	Pumped. Old well, new zone.

[1] Well completed in 1962. Source: Petroleum Information, 1963 Resume, Oil and Gas Operations in the Rocky Mountain Region.

NONMETALS

Nonmetal production, contributing 9 percent of the value of the State mineral output, was 10 percent above that of 1962. Production was recorded for cement, clays (bentonite, fire clay, and miscellaneous clay), gem stones, gypsum, lime, phosphate rock, pumice, sand and gravel, sodium carbonate (trona), sodium sulfate, stone, sulfur, and vermiculite.

Cement.—A slight increase in output and value was reported for cement in 1963. Monolith Portland Midwest Co., the only producer in the State, operated its plant at Laramie at the highest level of production in the company history. Much of the cement was used in the Interstate Highway System. The company used cement rock, coal, gypsum, limestone, and sandstone in producing cement products.

Clays.—Bentonite, fire clay, and miscellaneous clay were mined in Wyoming. The State was the leading producer of high-swelling bentonite in the Nation; the 1963 output of 991,000 tons was valued at $11.2 million, 3 percent more than in 1962. In order of output, approximately 36 percent of the bentonite was consumed in rotary drilling; 28 percent for pelletizing taconite iron concentrates; 24 percent in the foundry industry; 6 percent for enameling, chemicals, pelletizing, refractories, insecticides and fungicides, filtering and clarifying, and cements; 3 percent for other uses; and 3 percent was exported.

Producing companies in order of output were Magnet Cove Barium Corp., Big Horn County; Baroid Division of National Lead Co., two plants, one in Crook County and one in Weston; American Colloid Co., a plant in Weston County and some production from Crook County processed in a plant in South Dakota; Archer-Daniels-Midland Co., two plants, one in Crook County and one in Weston; International Minerals & Chemical Corp. (IMC), production in Crook County processed in South Dakota; Wyo-Ben Products Co., Big Horn County; Black Hills Bentonite Co., Crook County; and Benton Clay Co., Natrona County. Black Hills Bentonite Co. of Moorcroft announced plans to begin constructing a plant at Casper in May 1964. Bentonite from deposits near Kaycee in Johnson County was to be trucked about 80 miles to the plant. Within a few years the operation in Crook County was to be phased out by the new operation.

Miscellaneous clay produced included shale for lightweight aggregate by The Idealite Co. at Laramie; clay for building brick, vitrified sewer pipe, and other heavy clay products by The Lovell Clay Products Co. at Lovell; and clay for building brick by Sheridan Press Brick & Tile Co. at Sheridan and by Interstate Brick Co. at Salt Lake City, Utah.

Fire clay and stoneware clay were mined in Uinta County by International Pipe and Ceramics Corp. All clay from Uinta County was transported to Salt Lake City, Utah, for processing and marketing.

Gem Stones.—Estimated value of gem stones collected in Wyoming increased $25,000 over that of 1962. Commercial dealers, hobbyists, and gem-collecting societies reported finds of agate, fossils, jade (nephrite), petrified wood, and a variety of other gem materials and mineral specimens.

Gypsum.—The value of gypsum production increased 13 percent. Big Horn Gypsum Co.—purchased by The Celotex Corp., a building-materials manufacturing firm with operations in Texas, Ohio, and

Iowa—used gypsum to manufacture plasterboard at Cody. Wyoming Construction Co. mined gypsum for Monolith Portland Midwest Co. for use in producing cement. Multi Mineral Production Corp. sold and shipped gypsum, mined in 1955, for agricultural use.

Lime.—The value of quicklime production increased by $57,000. Quicklime was processed and used at beet-sugar refineries at Lovell, Torrington, and Worland.

Phosphate Rock.—Output of phosphate rock by San Francisco Chemical Co., the only producer in the State, increased 39 percent in 1963. The company operated a benefication plant in Lincoln County for upgrading ores mined in both Wyoming and Utah. The processed rock was used for manufacturing phosphoric acid and superphosphate fertilizers.

Susquehanna-Western, Inc., continued to investigate the feasibility of producing phosphate rock from deposits south of Lander in the Wind River Mountains, for eventual processing in its presently closed uranium mill at Riverton.

Pumice.—Tongue River Stone Co. of Sheridan reduced its output of scoria (pumice) in 1963; the scoria mine was operated only between May and October. The scoria was crushed and screened for use as railroad ballast.

Sand and Gravel.—Although production of sand and gravel increased 2 percent in 1963, the average value decreased from $1.04 in 1962 to $1.00 per short ton in 1963. Output, from 49 commercial operations and 84 Government-and-contractor operations, was reported for all counties and Yellowstone National Park. Ninety-eight percent of the sand and gravel was prepared for use by washing, crushing, or screening. Sand and gravel distribution, according to use, was 93 percent for paving, 4 percent for building, and 3 percent for fill, railroad ballast, and miscellaneous uses. In order of production, Natrona, Sweetwater, and Johnson Counties had the largest production. Companies reporting the largest output of commercial sand and gravel were Woodward Construction Co. operating in Lincoln, Sublette, and Sweetwater Counties; Boatright-Smith in Natrona County; Gilpatrick Construction Co., Inc., in Fremont County; Casper Concrete Co., Inc., in Natrona County; and Forgey Brothers Co. in Sublette, Lincoln, and Teton Counties.

Under the 1963 Wyoming highway program,[6] road-construction contracts totaled $51.3 million: $5.7 million in contracts was awarded for roads financed by the State, $12.5 million for roads in the Federal-aid primary and secondary (ABC) program, and $33.1 million under the Interstate Highway System. Planned expenditures for road construction in 1964 totaled $50.4 million: $3 million by the State, $10.1 million with ABC funds, and $37.3 million for the Interstate program. In the National Interstate program for 1963,[7] 52.4 miles of road was opened to traffic, bringing the total to 368.9 miles of road open to traffic since the program was started July 1, 1956; Wyoming was ranked 16th in total miles open to traffic. At yearend roads under construction or in engineering or right-of-way status totaled 196.2 miles and work in the preliminary stage or not yet in progress was 352.9 miles. The total designated mileage for the State was adjusted to 918 miles.

[6] Engineering News-Record. State Highway Contracts will Rise. v. 172, No. 13, Mar. 26, 1964, pp. 13–15.

[7] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1963. Press Release BPR 64–9, Feb. 7, 1964.

TABLE 9.—Sand and gravel production in 1963, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Big Horn	64	$62	Park	288	$277
Campbell	341	341	Platte	106	123
Carbon	547	553	Sheridan	286	285
Crook	252	280	Sweetwater	1,265	1,267
Fremont	484	369	Uinta	127	129
Hot Springs	24	25	Weston	80	80
Laramie	180	188	Undistributed [1]	2,073	2,112
Lincoln	300	302			
Natrona	1,450	1,447	Total	7,901	7,874
Niobrara	34	34			

[1] Includes the following counties for which figures are withheld to avoid disclosing individual company confidential data: Albany, Converse, Goshen, Johnson, Sublette, Teton, Washakie, and Yellowstone National Park.

TABLE 10.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1962		1963	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	116	$181	123	$165
Paving	118	83	339	345
Railroad ballast	5	1	(1)	(1)
Fill	34	13	52	26
Other	2	1		
Total	275	279	514	536
Gravel:				
Construction:				
Building	240	326	172	226
Paving	1,779	1,255	1,419	1,298
Railroad ballast	152	31	(1)	(1)
Fill	9	7	35	26
Other	7	8		
Miscellaneous	49	46	34	38
Total	2,236	1,673	1,660	1,588
Total sand and gravel	2,511	1,952	2,174	2,124
Government-and-contractor operations:				
Sand:				
Building	(2)	(3)	(2)	(3)
Paving	86	47	36	36
Total	86	47	36	36
Gravel:				
Building	128	115	35	31
Paving	4,990	5,967	5,576	5,603
Fill	34	13	80	80
Other	20	10		
Total	5,172	6,105	5,691	5,714
Total sand and gravel	5,258	6,152	5,727	5,750
All operations:				
Sand	361	326	550	572
Gravel	7,408	7,778	7,351	7,302
Total	7,769	8,104	7,901	7,874

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Fill."
[2] Less than 500 short tons.
[3] Less than $500.

Sodium Carbonate and Sulfate.—Production and value of sodium carbonate (soda ash) increased 163,000 tons and $3.8 million more than in 1962. The two producing companies, Inorganic Chemical Division of FMC Corp. and Stauffer Chemical Co. of Wyoming, reported significant increases in output. A plant enlargement program was started by Stauffer Chemical Co., to be completed in the 4th quarter of 1964, to increase annual capacity from 200,000 to 400,000 tons.

FMC Corp. announced a $5 million expansion program at its Westvaco facilities about 22 miles west of Green River to be completed by the end of 1964. The new plant addition was to produce sodium tripolyphosphate, used in manufacturing household detergents. Elemental phosphorus, produced by the company near Pocatello, Idaho, was to be combined with Wyoming trona (sodium carbonate) to make the product.

Texas Gulf Sulphur Co. was the successful bidder for leasing 12 square miles of Government-owned, trona-bearing land in three areas in the Green River basin.

William E. Pratt reduced the output of natural sodium sulfate from saline lake deposits in Natrona County.

Stone.—Production of stone increased 11 percent, but the value decreased 2 percent compared with that of 1962. Except for 0.4 percent that was dimension sandstone used for constructing and decorating buildings, all of the stone was crushed and broken; limestone accounted for 63 percent; granite for 32; and marble, miscellaneous stone, and sandstone for 5. The limestone was used for producing cement and lime and as flux, mineral food, railroad ballast, riprap, and road-construction aggregate; granite as railroad ballast,, riprap, and roadstone; marble for decorative roofing and driveway chips and as exposed aggregate in decorative building; miscellaneous stone as concrete and roadstone, exposed aggregate in decorative building, fertilizer, and riprap; and sandstone for producing cement and as riprap.

Sulfur.—Five companies recovered sulfur from hydrogen sulfide-bearing natural gas. Sulfur shipments (60,000 long tons) were valued at $921,000 or 41 percent less than in 1962. Plant operators, according to output, were Pan American Petroleum Corp. in Park and Washakie Counties; Texas Gulf Sulphur Co. in Washakie County; Texaco Inc. in Park County; and Gas Processors, Inc., in Big Horn County.

Sinclair Refining Co. announced that the new sulfur recovery unit included in the construction and modernization program of its petroleum refinery at Sinclair was scheduled for completion early in 1964. Atlantic Refining Co., at the Riverton Dome field, completed a new gas-processing plant that included a 12-long-ton-per-day sulfur recovery unit.

Western Nuclear, Inc., at Jeffrey City, and Susquehanna-Western, Inc., at Riverton, made sulfuric acid from elemental sulfur for use in processing uranium ores.

Vermiculite.—Two companies reported a small production of vermiculite: D. L. Howe from an operation near Wheatland and Golden Clover Corp. from an operation near Encampment.

TABLE 11.—Stone production in 1963, by counties

County	Short tons	Value	County	Short tons	Value
Carbon	15,509	$21,293	Platte	336,178	$522,217
Johnson	8,007	6,806	Yellowstone National Park	1,748	1,748
Laramie	821,810	1,238,646	Undistributed [1]	635,459	1,121,229
Lincoln	114,380	69,800	Total	1,939,965	2,990,739
Natrona	6,874	9,000			

[1] Includes the following counties for which figures are withheld to avoid disclosing individual company confidential data: Albany, Big Horn, Crook, Goshen, and Teton.

METALS

The value of metals production, increasing 39 percent, contributed 9 percent toward the State total value. Production was recorded for beryllium concentrate, gold, iron ore, uranium ore, and vanadium.

Beryllium.—Less than one-half ton of hand-cobbed beryl was recovered from a small operation in Fremont County.

Gold.—Four ounces of gold valued at $140 was recovered from a stream placer deposit in Teton County.

Iron Ore.—Reflecting the first full-year operation of the Columbia-Geneva Steel Division, United States Steel Corp., at the Atlantic City iron-ore project, production of iron ore increased 117 percent and value 172 percent. Taconite iron ore was mined from an open pit, crushed, ground, concentrated by a magnetic separation method, and agglomerated at facilities near the Continental Divide in western Fremont County.

The Colorado Fuel and Iron Corp. (CF&I) operated the Sunrise iron mine in Platte County throughout the year, producing hematite iron ore that was processed at the company iron and steel plant at Pueblo, Colo. The company announced plans to build a beneficiation plant at the mine site. The concentrating method to be used featured gravity separation by jigging of small sizes of ore, and heavy-media separation of course sizes of ore.[8] The company planned to mine lower grade ore and to produce a concentrate containing about 55 percent iron.

Magnetite Products Corp. and Lodestone Mining Co. produced titaniferous magnetite ore from Albany County for use as heavy aggregate in concrete for coatings of underwater pipe and for shielding fissionable materials.

Uranium Ore.—Production and shipments of uranium ore from mines in Wyoming increased 13 percent and value increased 6 percent in 1963. The first full-year operation of the open pit and processing plant by Petrotomics Co. partly accounted for this increase. Output from 81 operations in 9 counties was processed at mills in Wyoming, Colorado, and South Dakota. The quantity of recoverable uranium oxide from ores produced within the State was 6.5 million pounds, having a value of $52.3 million.

[8] Mining Engineering. Beneficiation Plant Slated at CF&I's Sunrise Mine. V. 15, No. 11, November 1963, p. 10.

TABLE 12.—Mine production of uranium ore, by counties [1]

County	1962				1963			
	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]
Big Horn	5	732	3,905	$15,666	4	293	2,590	$11,483
Campbell	4	(3)	(3)	(3)	2	(3)	(3)	(3)
Carbon	19	177,243	1,413,980	6,162,770	6	195,197	1,099,912	4,588,441
Converse	5	16,771	77,957	319,443	10	175,273	511,829	1,574,244
Crook	5	93,333	415,669	1,671,486	6	73,454	322,631	1,296,051
Fremont	35	878,596	4,134,317	16,643,099	47	978,388	4,803,040	19,336,242
Johnson	1	61	162	412	1	(3)	(3)	(3)
Natrona	5	(3)	(3)	(3)	4	(3)	(3)	(3)
Sweetwater					1	(3)	(3)	(3)
Undistributed		135,048	340,220	902,484		52,465	148,943	436,499
Total	79	1,301,784	6,386,210	25,715,360	81	1,475,070	6,888,945	27,242,960

[1] Receipts at mills based on data supplied to the Bureau of Mines by AEC.
[2] F.o.b. mine value; base price, grade premiums, and exploration allowances. Calculated according to AEC Circ. 5, rev., price schedule.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Six plants in Wyoming processed uranium ore in 1963. Susquehanna-Western, Inc., however, closed the Riverton uranium-ore processing mill in May and assigned all ore formerly committed to the facilities at Riverton to the mill operated by Federal-Gas Hills Partners in the Gas Hills. In accordance with an agreement with Federal-Gas Hills Partners, Susquehanna-Western, Inc., continued to purchase ore for processing and to ship concentrate recovered at the Gas Hills mill.

Uranium properties of Vitro Minerals Corp. in the Gas Hills were purchased by Federal-Gas Hills Partners. At its property in the Shirley basin, Utah Construction & Mining Co. continued research to recover uranium by direct leaching of ore-in-place. Homestake Mining Co. obtained leases from Western Standard Uranium Co. on mining claims covering more than 1,000 acres in the Shirley basin. Western Nuclear, Inc., with uranium-mining operations in Converse and Fremont Counties, completed an agreement with the U.S. Atomic Energy Commission (AEC) to extend the purchasing contract of uranium concentrates through 1970. Negotiations with the AEC for extending contracts until 1970 continued with Utah Construction & Mining Co.; Globe Mining Co., Division, Union Carbide Corp.; and Federal-Gas Hills Partners. Petrotomics Co. in the Shirley basin, however, had not requested an extension because of economic reasons pertaining to its allocations.

Vanadium.—Recovery of vanadium from uranium ores mined in Wyoming decreased 2 percent in quantity and value in 1963. Mines Development, Inc., at Edgemont, S. Dak., processed the uranium ore and recovered the vanadium.

REVIEW BY COUNTIES

Albany.—Monolith Portland Midwest Co., at Laramie, operating the State only cement plant, accounted for most of the minerals produced in the county: Cement rock, gypsum, limestone, and sandstone. The Idealite Co. mined shale and expanded it into lightweight ag-

gregate in operations adjacent to the cement plant. Output of shale for lightweight aggregate was less than that produced in 1962 mainly because a new plant of The Idealite Co. supplied the Denver, Colo., markets. Iron-ore production, used for heavy aggregates, decreased 26 percent. Magnetite Products Corp., to be called Plicoflex, Inc., in 1964, produced iron ore from deposits west of Farthing, and Lodestone Mining Co. produced iron ore from the Shanton deposits northeast of Bosler. Petroleum production, increasing by 108,000 barrels during the year, came from four fields; Quealy Dome field had the largest output with 704,000 barrels. Sand and gravel production, less than that of 1962, was reported by three operators compared with five in 1962.

TABLE 13.—Value of mineral production in Wyoming, by counties

County	1962 [1]	1963 [2]	Minerals produced in 1963 in order of value
Albany	$6,660,568	$6,967,579	Cement, petroleum, stone, sand and gravel, iron ore, clays, gypsum, gem stones.
Big Horn	30,069,731	30,473,172	Petroleum, clays, natural gas, lime, sand and gravel, stone, uranium ore, gem stones.
Campbell	14,339,355	21,683,625	Petroleum, coal, sand and gravel, natural gas, LP gases, uranium ore.
Carbon	15,716,946	16,723,736	Petroleum, uranium ore, coal, sand and gravel, natural gas, LP gases, stone, gem stones, vermiculite.
Converse	14,066,867	16,113,286	Petroleum, coal, uranium ore, LP gases, natural gasoline, sand and gravel, natural gas, vanadium, gem stones.
Crook	22,869,929	23,075,997	Petroleum, clays, uranium ore, vanadium, stone, sand and gravel, natural gas.
Fremont	56,044,824	69,612,478	Petroleum, uranium ore, iron ore, natural gas, natural gasoline, sand and gravel, LP gases, gem stones, beryllium concentrate.
Goshen	174,610	232,983	Lime, sand and gravel, petroleum, stone.
Hot Springs	52,174,039	59,430,925	Petroleum, natural gas, natural gasoline, coal, sand and gravel.
Johnson	17,349,662	18,435,094	Petroleum, sand and gravel, natural gas, LP gases, natural gasoline, stone, gem stones, uranium ore.
Laramie	1,772,996	2,515,646	Stone, petroleum, sand and gravel, natural gas.
Lincoln	3,943,892	5,671,111	Coal, phosphate rock, LP gases, sand and gravel, stone.
Natrona	36,715,631	42,375,588	Petroleum, natural gasoline, natural gas, sand and gravel, LP gases, uranium ore, clays, gem stones, sodium sulfate, stone.
Niobrara	2,997,010	2,595,000	Petroleum, natural gas, sand and gravel, LP gases.
Park	90,406,908	90,589,063	Petroleum, natural gasoline, natural gas, LP gases, gypsum, sand and gravel.
Platte	3,002,106	(3)	Iron ore, stone, sand and gravel, gem stones, vermiculite.
Sheridan	3,090,808	3,075,710	Petroleum, coal, sand and gravel, pumice, clays.
Sublette	17,201,375	22,316,000	Natural gas, petroleum, sand and gravel, LP gases.
Sweetwater	46,674,532	48,102,698	Petroleum, sodium carbonate, natural gas, sand and gravel, LP gases, coal, natural gasoline, gem stones, uranium ore.
Teton	94,220	372,028	Sand and gravel, stone, gem stones, gold.
Uinta	1,760,233	1,193,780	Natural gas, sand and gravel, clays, natural gasoline, petroleum.
Washakie	9,056,120	8,845,979	Petroleum, natural gas, LP gases, lime, sand and gravel.
Weston	11,332,106	10,766,443	Petroleum, clays, LP gases, natural gas, sand and gravel.
Yellowstone National Park	21,400	(3)	Sand and gravel, stone.
Undistributed [4]	5,034,361	3,464,764	
Total	462,570,000	504,633,000	

[1] Most county figures have been revised.
[2] Petroleum value is preliminary.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Includes some sand and gravel (1962), stone, and gem stones that cannot be assigned to specific counties.

Big Horn.—Petroleum provided 84 percent of the value of mineral output in the county. Of the 17 productive fields, the largest was Garland with 4.6 million barrels, followed by Byron with 2.9 million, Bonanza with 847,000, and Sage Creek with 544,000 barrels. Crude oil output was approximately the same as in 1962. Natural gas production increased 7 percent. Bentonite was second to petroleum in value of minerals produced. Magnet Cove Barium Corp., operating the largest bentonite plant in the State, produced 10 percent more than in 1962; Wyo-Ben Products Co. produced 41 percent more. Wyo-Ben Products Co. purchased a fleet of 30-ton trucks and installed railroad bulk-loading facilities. Using a local variety of clay, The Lovell Clay Products Co. continued to manufacture building brick, heavy clay pipe, tile products, and fire brick at Lovell. The Great Western Sugar Co. processed and used lime at its beet-sugar refining plant at Lovell. Four properties, operated for uranium ore, had a total output valued at $11,500.

Campbell.—Petroleum production from 24 fields, 7 more than in 1962, advanced 54 percent in 1963. Fields with largest output were Timber Creek with 2 million barrels, Raven Creek with 1.6 million, Rozet with 1.2 million, and Halverson Ranch with 954,000. Eight new fields or pay zones were discovered. Processing natural gas in two plants at Rozet field, Gas Processors, Inc., and N. C. Ginther recovered 4.3 million gallons of LP gases, 305,000 gallons less than in 1962.

Wyodak Resources Development Corp., a subsidiary of Black Hills Power and Light Co., operated the second largest strip-coal mine in the State near Gillette, producing from a coal seam ranging in thickness from 40 to 102 feet. Uranium output, 1,170 tons more than in 1962, came from two operations.

Carbon.—Petroleum output from 15 fields, compared with 14 in 1962, increased 13 percent, providing 53 percent of the value of minerals produced in the county. Wertz field had the largest production, 2.3 million barrels; Rock River field had 616,400 barrels. Wildcat drilling resulted in one oil and one gas discovery. Although Sinclair Refining Co. at Sinclair reduced refinery throughput by 5 percent, refinery output was second highest in the State. The company multimillion-dollar modernization program at the 40-year-old refinery was scheduled for completion early in 1964; a sulfur recovery unit was constructed in the 1963 work program. Marathon Oil Co. produced 2.1 million gallons of LP gases at its natural gas processing plant near Rock River.

Uranium ore operations in the county were reduced from 19 in 1962 to 6 in 1963. Union Carbide Nuclear Co. Division, Union Carbide Corp., and Sigma Mining Co. produced from two operations each in the Poison basin area west of Baggs; and Petrotomics Co. and Utah Construction & Mining Co. produced from mines in the Shirley basin. Petrotomics Co. mined and processed the largest tonnage of uranium ore from its open pit. To participate in the AEC stretchout program, Utah Construction & Mining Co. curtailed output from its mining operation. The company continued experiments with solution-mining techniques and, according to the annual report of the State Inspector of Mines, produced 17,000 tons of uranium-bearing

slurry, which was trucked to the Lucky Mc mill of the company in the Gas Hills. Output by solution mining was about three times the quantity produced by this method in 1962.

The value of coal output increased $967,000 over that of 1962. Much of this increase was produced by Rosebud Coal Sales Co., Monolith Portland Midwest Co., and Hanna Basin Coal Co. from strip mines near Hanna. The Thomas Coal mine, with an output of less than 500 tons, was closed in March.

Sand and gravel production in the State increased substantially, mostly because of work on the Interstate Highway System. Crushed miscellaneous stone was produced by a contractor of the Federal Forest Service and by Seahorn Bros. Rawlins Redstone Development Co. produced a small quantity of dimension sandstone for local building use. Golden Clover Corp. shipped a few tons of vermiculite mined from the Platt deposit near Encampment.

Converse.—Petroleum from eight fields provided 63 percent of the value for the county mineral production; crude oil output was greater by 278,000 barrels over that of 1962. Principal oilfields included Glenrock South with 2 million barrels and Big Muddy with 1.6 million barrels. Cabot Corp. at the Glenrock field and McWood Corp., formerly Tower Mesa Verde Oil & Gas Co., at the Flat Top Field processed natural gas and recovered 11.5 million gallons of propane and butane and 4.7 million gallons of natural gasoline. Natural gas production, slightly below that of 1962, was 1.1 billion cubic feet.

Three operators reported coal production. Pacific Power & Light Co.[9] increased output in 1963 at its Dave Johnston strip mine by 263,000 tons. Best Coal Co. operated the Antelope strip mine; American Humates, Inc., mined the coal-like mineral leonardite from deposits north of Glenrock for use in manufacturing a plant-and-lawn fertilizer high in humic acid. The company, a subsidiary of Concho Petroleum Co. of Dallas, Tex., planned a fourfold increase in its operations, with output expected to advance to 150 tons per day. Completion of the third and largest unit of the Dave Johnston powerplant in June 1964 required programming for increased coal production.

A large increase in uranium production resulted from the operation of the Spook open-pit mine and upgrading plant of Western Nuclear, Inc., in the Dry Fork area, about 40 miles north of Douglas. Vernon A. Mrak; B. & H. Mines, Inc.; Hamlin Exploration & Mining Co.; and Kelley Construction Co. also mined uranium ore from the Dry Fork area. All uranium ore, except that from Kelley Construction Co. and Western Nuclear, Inc., was processed in a mill of Mines Development, Inc., at Edgemont, S. Dak. Uranium-bearing slurry from the Spook upgrading plant of Western Nuclear, Inc., was trucked to the company mill at Jeffrey City for final processing. Vanadium was recovered as a byproduct of the uranium-ore processing at the Edgemont mill.

Sand and gravel production more than doubled during the year. Government crews and contractors accounted for most of the production. Gem stones collected were valued at $4,000. The Eloxite Corp. of Wheatland marketed black jade produced from a new source near Douglas.

---

[9] Annual Report of the State Inspector of Mines of Wyoming for Year Ending Dec. 31, 1963, p. 13.

Crook.—Petroleum accounted for 68 percent, bentonite for 21 percent, and uranium ore for 6 percent of the value of minerals produced in the county. Petroleum output, an increase of 5.5 percent over that of 1962, came from 25 fields, 4 more than in 1962. Coyote Creek with 2.2 million barrels was the largest producing field, followed by Donkey Creek with 908,000 barrels. Four crude-oil discoveries resulted from wildcat drilling. Natural gas output increased by 124 million cubic feet over that of 1962.

Five companies produced 9 percent less bentonite in 1963 than in 1962. The Baroid Division of National Lead Co., Archer-Daniels-Midland Co., and Black Hills Bentonite Co. operated mills in the county; American Colloid Co. processed bentonite mined in the northeastern part of the county in plants near Upton and at Belle Fourche, S. Dak., and IMC processed bentonite mined in the county at its mill near Belle Fourche.

Uranium-ore production was reduced by 21 percent in 1963. Homestake Mining Co.; Balboa Mining & Development Co.; and Geo. Resources Exploration, Inc., operated mines in the vicinity of Hulett. The Hauber underground mine of Homestake Mining Co. had the largest output. Uranium ore produced in the county was processed by Mines Development, Inc., at Edgemont, S. Dak. Vanadium recovered as a byproduct of uranium-ore processing decreased 5 percent.

Crushed stone and sand and gravel production increased significantly because of more road construction in the county.

Fremont.—The county maintained second position in value of total mineral production. Mineral output increased in value by $13.6 million, or 24 percent, in 1963. Petroleum and uranium ore provided 45 and 28 percent of the value, respectively, with iron ore, natural gas, LP gases, sand and gravel, gem stones, and beryllium concentrate providing the remaining 27 percent. Crude oil production came from 27 fields, 1 less than for 1962; Beaver Creek field, with 3.1 million barrels, had the largest production, followed by Steamboat Butte with 2.6 million barrels, Winkleman Dome with 2.3 million barrels, and Big Sand Draw with 1.2 million barrels. Natural gas production, totaling 18.6 billion cubic feet, was slightly higher than in 1962. Pan American Petroleum Corp. began expanding its plant at Beaver Creek to a capacity of 81 million cubic feet of gas per day. A sulfur-recovery unit was included in the expansion program. Seven miles from Riverton, Atlantic Refining Co. began operating a new gas-sweetening plant for recovering natural gasoline and sulfur. Plant capacity was rated at 9,660 gallons of gasoline and LP gases and 28,000 pounds of elemental sulfur per day. Natural gas processing in 1963 yielded 8.3 million gallons of natural gasoline and 8 million gallons of LP gases, having a combined value of $860,000.

Fremont led the counties of the State in producing uranium ore, the preponderance coming from the Gas Hills locality,[10] with lesser quantities from Crooks Gap and Copper Mountain areas. Previously, almost all production from the Gas Hills was from open-pit mines; during 1963, however, Atlas Minerals Division, Atlas Corp., produced from the underground Lisbon mine, and several operators mined from underground workings beyond walls of open pits.

[10] Gullinger, R. R. Source of Uranium in the Gas Hills Area, Wyoming. Econ. Geol., v. 58, No. 2, March–April 1963, pp. 285–286.

TABLE 14.—Uranium operators in Fremont County in 1963

Operator	Locality	Type of mine
Atlas Corp.	Gas Hills	Open pit and underground.
Continental Uranium Company of Wyoming	Crooks Gap	Underground.
Federal-Gas Hills Partners	Gas Hills	Open pit.[1]
Fremont Uranium Corp.	Copper Mountain	Do.
Green Mountain Uranium Corp.	Crooks Gap	Underground.
Dale B. Levi	Gas Hills	Open pit.
P. C. Mining Corp.	do.	Do.
Peters Mining Co.	do.	Do.
Malcolm J. Reeves	Copper Mountain	Do.
Sharrock & Pursel	Gas Hills	Do.
Susquehanna-Western, Inc.	Copper Mountain	Underground.
Union Carbide Corp. (Globe Mining Co. Div.)	Gas Hills	Open pit.[1]
Utah Construction & Mining Co.	do.	Do.[1]
Vitro Minerals Corp.	do.	Do.
Western Nuclear, Inc.	do.	Do.[1]
Do.	Crooks Gap	Do.[1]

[1] Some underground operations conducted from the floor of the open pits.

Source: U.S. Atomic Energy Commission.

To obtain economic advantages by participating in the AEC stretchout purchasing program, Susquehanna-Western, Inc., closed its uranium-ore processing mill at Riverton. Ore assigned to the Riverton facilities was directed to the mill of Federal-Gas Hills Partners in the Gas Hills. The mills of Utah Construction & Mining Co. and Western Nuclear, Inc., were operated at reduced production rates throughout the year because of expected participation in the AEC stretchout purchasing program. Federal-Gas Hills Partners purchased properties of Vitro Minerals Corp. Because of the additional ore from the former Vitro Minerals mines and from allocations of Susquehanna-Western, Inc., Federal-Gas Hills Partners operated its mill at or near capacity throughout the year. Utah Construction & Mining Co. began using an electronic computer to facilitate mining operations. The computer was used on engineering problems including ore-reserve calculations, production scheduling, and economic determination of pit limits. Western Nuclear, Inc., began developing the deepest open pit in the Gas Hills, the D–1 pit of the Day-Loma complex, planned for 370 feet deep. Green Mountain Uranium Corp. and Continental Uranium Co. continued underground operations in Crooks Gap area south of Jeffrey City; these companies elected not to participate in the AEC stretchout purchasing program. Continental Uranium Co. began producing from the Reserve shaft, having virtually completed mining from the Seismic-shaft area. The Reserve shaft, 585 feet deep, was the deepest underground uranium mine in Wyoming. Western Nuclear, Inc., and Susquehanna-Western, Inc., manufactured sulfuric acid, mainly for use in uranium processing.

Columbia-Geneva Steel completed in 1963 the first year of continuous operation at the Atlantic City iron ore project. Taconite-iron ore agglomerates—produced from the mining, concentrating, and agglomerating facilities—contained in excess of 60 percent iron. Full-capacity production was a year ahead of schedule. The iron agglomerates from this operation greatly enhanced the efficiency of the blast furnaces at Provo, Utah, and placed them on a much better cost basis.

Sand and gravel output was 30 percent less than in 1962. Gem stones collected were valued at $24,000.

Goshen.—Mineral-production value increased 33 percent in 1963. Lime provided the bulk of the total value, followed by sand and gravel, petroleum, and crushed marble. Holly Sugar Co. increased lime output for its beet-sugar refinery at Torrington. Sand and gravel output for road construction increased substantially. Wyoming Marble & Stone Co. produced crushed marble for precast concrete forms, roofing chips, and colorful ground-cover rock. The Torrington oilfield yielded 9,000 barrels of petroleum, compared with 11,000 barrels for 1962.

Hot Springs.—The county was second in value of petroleum production and third in value of total minerals produced in the State. Crude oil output, increasing from 20.8 to 23.6 million barrels, provided 99 percent of the total mineral value. Production came from 15 fields, the largest being Hamilton Dome with 10.7 million barrels, followed by Grass Creek with 5.3 million, Little Buffalo with 2.2 million, and Murphy Dome with 1.9 million. The Empire State Oil Co. refined an estimated 2.7 million barrels of oil, a decrease of 9 percent for the year. Natural gas production decreased 30 percent. Gas Processors, Inc., processed natural gas from the Grass Creek field and recovered 23 percent more natural gasoline than in 1962.

The production of coal for Dusky Diamond Coal Co.; Roncco Coal Co., Inc.; and T–K Coal Co. was below that of 1962. Sand and gravel produced in the county increased from 9,000 tons in 1962 to 24,000 tons in 1963.

Johnson.—Petroleum provided 88 percent of the value of county mineral production, followed by sand and gravel, natural gas, and LP gases. Crude oil output, from nine fields, increased 216,000 barrels or 4 percent over that of 1962; the largest output was reported from Sussex field with 2.8 million barrels, North Fork with 967,000, and Meadow Creek with 826,000. Natural gas production decreased 700 million cubic feet. Continental Oil Co. continued processing natural gas from the Sussex field and recovered LP gases and natural gasoline.

Sand and gravel production was more than three times that of 1962. Granite rock was mined and crushed by a contractor of the Forest Service for use as roadstone. Black Hills Bentonite Co. explored large deposits of bentonite near Kaycee; a study by the Chicago & North Western Railway Co. indicated reserves of approximately 40 million tons.[11] Black Hills Bentonite Co., processors of bentonite in Crook County, announced plans for a plant at Casper to be constructed in 1964 for processing bentonite from Johnson County.

Laramie.—Mineral-output value was divided among crushed stone with 49 percent, petroleum with 43, sand and gravel with 7.5, and natural gas with less than 1. Two operators produced crushed stone. The Great Western Sugar Co. mined limestone from its underground operation at Horse Creek. Most of the crushed and screened product was for beet-sugar refining; some was also used for roadstone, railroad ballast, and metallurgical flux. Union Pacific Railroad Co., contracting with Morrison-Knudsen Co., Inc., produced crushed granite at Granite Mountain for railroad ballast and riprap. Sand and gravel production was five times that of 1962.

[11] Wyoming Progress Reports. Black Hills Bentonite Explores Giant Deposit. V. 3, No. 1, June 1963, p. 2.

Crude oil output came from six fields, one more than for the previous year. The Horse Creek field was the largest, with an output of 223,000 barrels. Frontier Refining Co. operated the State fourth largest oil refinery at Cheyenne; throughput for the year was 5.4 million barrels, a decrease of 16 percent compared with that of 1962. Colorado Interstate Gas Co. announced plans to construct a $6 million ammonia plant near Cheyenne for producing nitrogen fertilizer and allied products. The plant, scheduled for completion about February 1965, was to be operated by Wycon Chemical Co., a newly created division of Colorado Oil & Gas Corp. Annual production was planned for 18,000 tons of anhydrous ammonia and 33,000 tons of ammonia nitrate fertilizer. In the process about 5 million cubic feet of natural gas per day was to be used.

Lincoln.—In order of value, mineral commodities produced were coal, LP gases, phosphate rock, sand and gravel, and crushed limestone. The county was ranked second in the State in coal production, which came from three mines operated by Kemmerer Coal Co. The Sorensen strip mine, which began operations in 1963, exceeded the combined output of the Elkol strip and the Brilliant No. 8 underground mines. Coal from the Sorensen mine was produced entirely for the Utah Power & Light Co. new coal-based powerplant near Kemmerer. Arrangements were made with representatives of the Agriculture College of the University of Wyoming for studies to determine a program to reclaim mined-out coal lands in the vicinity of the Elkol and Sorensen mines. Reclaiming of the lands was to include filling existing pits and contouring and seeding the area by Kemmerer Coal Co. The subbituminous coking-coal joint venture of FMC Corp. and United States Steel Corp. was terminated during the year after several successful tests were completed with the coke briquettes in the electric furnace used for processing elemental phosphorus and in the iron and steel furnaces.[12]

San Francisco Chemical Co. increased phosphate rock output 39 percent over that of 1962. From the company-operated open pit and concentrating plant near Sage, concentrate was shipped to out-of-State purchasers for agricultural uses in fertilizers and industrial uses in manufacturing phosphoric acid. Crushed and broken stone output increased about threefold over that of 1962. All of the stone was produced and used as riprap by a contractor of the Bureau of Reclamation at the Fontenelle Dam and Reservoir on the Green River for the Bureau Seedskadee project. Sand and gravel production increased over that of 1962.

El Paso Natural Gas Co. produced LP products at a natural gas processing plant at Opal; the natural gas came from the Big Piney field in Sublette County. The average daily throughput for the plant increased from 229.4 million cubic feet in 1962 to 235.3 feet in 1963.

Natrona.—Value of mineral production increased 15 percent over that of 1962: Petroleum accounted for 85 percent; natural gasoline 4;

[12] Coal. Coking Western Coals. V. 68, No. 12, December 1963, pp. 90–92.

natural gas 4; sand and gravel 3; LP gases 2; and uranium ore, bentonite, gem stones, sodium sulfate, and stone 2. Petroleum production from 31 fields, 5 more than for 1962, increased 1.9 million barrels. Principal oilfields were Salt Creek with an output of 8.6 million barrels, Grieve Unit with 2.2 million, and Salt Creek-East with 594,000. Two new oil fields were discovered in the Wind River basin. Three refineries at Casper processed crude oil: American Oil Co., operating the largest refinery in the State, increased throughput by 19 percent to 10.3 million barrels; Texaco Inc. reduced its throughput by 4 percent to 8.7 million; and Socony-Mobile Oil Co., Inc., increased its throughput by 21 percent to 4.6 million. Pan American Petroleum Corp. processed natural gas at the Salt Creek field plant, operating with a daily average throughput of 28 million cubic feet and an average daily output of 29,000 gallons of propane, 34,000 gallons of butane, and 43,000 gallons of natural gasoline. Amax Petroleum Corp. processed natural gas in a new plant at the Boone Dome field, with a daily average throughput of 6 million cubic feet and an average daily output of 4,900 gallons of propane and 2,700 gallons of butane. Natural-gas production was 1.9 billion cubic feet more than in 1962.

Globe Mining Co. produced uranium ore from four deposits in the county; the company, operating its mill in the eastern Gas Hills area, processed ores from Natrona and Fremont Counties. Company production from deposits in the county was about half that of 1962; part of the reduction reflected the company participation in the stretchout purchasing program of AEC.

Benton Clay Co., operating mines near Midwest and Natrona, increased bentonite output 20 percent; the bentonite was processed in the company plant at Casper. Black Hills Bentonite Co. announced plans to construct a 600-ton-per-day bentonite plant at Casper for processing material developed near Kaycee in Johnson County. The plant was to be completed in October 1964. Sand and gravel output was 245,000 tons more than in 1962; the county was ranked first in the State in total output. Crushed-stone production of 6,900 tons was used on projects by contractors of the Bureau of Reclamation. Gem stones collected were valued at $34,000. William E. Pratt continued to harvest sodium sulfate from a saline lake deposit near Natrona.

Niobrara.—Value of mineral production, declining 13 percent, was divided among petroleum with 94 percent of the total value, natural gas with 3, LP gases with 2, and sand and gravel with 1. Crude-oil output came from nine fields, the largest being Lance Creek with 603,000 barrels. Natural gas was processed by Marathon Oil Co. at the Lance field plant; average daily throughput was reduced from 2.1 to 1.7 million cubic feet in 1963. The average daily output was 725 gallons of propane, 680 gallons of butane, and 2,520 gallons of combined gasoline and LP gases. Two operators reported sand and gravel production.

Park.—The mineral production for Park County, the highest in the State, was about the same as in 1962. The county, with 25 oilfields—1 more than reported in 1962—had the largest petroleum production in the State; fields with output of more than 1 million barrels were Elk Basin with 19.4 million, Oregon Basin with 6.5 million, Frannie

with 2.1 million barrels, and Fourbear with 1.5 million. Husky Oil Co. increased output at its Cody refinery by 1 percent, processing 3.1 million barrels of petroleum. Natural gas output in 1963 was 15.5 billion cubic feet, decreasing approximately 1 billion cubic feet. Pan American Petroleum Corp. operated the Elk Basin field natural gas plant at an average daily throughput of 16.4 million cubic feet and with an average daily output of 18,500 gallons of propane, 31,000 gallons of butane, and 48,000 gallons of gasoline. Gas Processors, Inc., operated two plants in the county: The Elk Basin plant had an average daily output of 1,000 gallons of gasoline, and the South Elk Basin field 1,900 gallons of gasoline. The natural gasoline output was 23 percent more and the LP gases were 6 percent less than in 1963. Elemental sulfur was recovered from sour gas at The Pan American Petroleum Corp. Elk Basin plant and at the Texaco Inc. Silver Tip plant. Husky Oil Co. and Planet Engineers, Inc., announced plans to construct a jointly owned gas-processing plant and related pipelines to the Silver Tip and Ralston fields in the Big Horn basin. LP gases and sulfur were to be produced at the plant, scheduled for completion in December 1964.

Big Horn Gypsum Co. increased gypsum output by 16 percent for its plasterboard plant at Cody. Taggert Construction Co. mined the gypsum for Big Horn Gypsum Co. From a stockpile accumulated in 1955, Multi Mineral Production Corp. shipped a small quantity of crushed gypsum for agricultural use.

Sand and gravel production from 10 operations increased from 88,000 tons in 1962 to 288,000 tons in 1963.

Platte.—Iron ore was the dominant mineral for Platte County, followed by stone and sand and gravel. Iron-ore production from the CF&I Sunrise mine increased 8 percent. During the year the company began constructing, at the mine site, a beneficiation plant to have a yearly capacity of 600,000 net tons of concentrate with an iron content of 55 percent. For the hematite type of iron ore produced, a gravity and heavy-media separation method was suited to the operation. The new plant was to upgrade lower grade ores and thereby increase the mineral reserves of the deposit. Use of the concentrate at the company-owned iron and steel plant at Pueblo, Colo., was to increase operating efficiency.

Guernsey Stone Co. increased the output of crushed and broken dolomite used for railroad ballast, riprap, and roadstone over that of 1962. W. C. Graves mined, crushed, and sized miscellaneous stone for use as aggregate in precasting concrete forms. Basins Engineering Co., Inc., with uranium holdings in Carbon County, announced plans to purchase The Great Western Sugar Co. old factory at Wheatland, which was to be converted to a plant for crushing, screening, and bagging marble aggregate. Marble and other rock minerals in the Wheatland area were to be processed and sold as terrazzo-floor and roofing chips, landscaping-cover rock, and exposed aggregate for exterior building panels. The plant was scheduled to be in operation in June 1964. Collectors reported gem stones valued at $7,000. From a deposit near Wheatland, D. L. Howe produced 180 tons of vermiculite valued at $1,250. Sand and gravel output, reported by four producers, was one-third that of 1962.

Sheridan.—Petroleum provided 49 percent, coal 41 percent, and miscellaneous clay, pumice (scoria), and sand and gravel 10 percent of the value of mineral production. Petroleum output, which decreased almost 100,000 barrels compared with 1962, came from the Ash Creek South field with 339,500 barrels and the Ash Creek field with 237,000 barrels. Coal production, from strip mines of Big Horn Coal Co. and Welch Coal Co., increased 19,000 tons to 376,000 tons.

Scoria (pumice) output decreased 32 percent; the crushed and sized products were used for railroad ballast. Sheridan Press Brick & Tile Co. mined clay for manufacturing building brick. Sand and gravel production was more than double that of 1962.

Sublette.—The value of mineral output was 30 percent greater in 1963; petroleum provided the increase. Crude oil production from 15 fields advanced from 2.2 million barrels in 1962 to 4.2 million in 1963; fields with largest output were Birch Creek with 1.3 million barrels, Green River Bend with 799,000, Pig Piney Shallow with 686,000, and La Barge with 385,000. Two new oil discoveries were made within the county. Natural gas production, about the same in 1963, accounted for 51 percent of the value of mineral production. California Oil Co., Western Division, operated a new natural gas processing plant at Birch Creek field; the plant had a daily average throughput of 17 million cubic feet per day and an average daily output of 6,650 gallons of combined LP gases and gasoline.

Sand and gravel production was reported from two operations. Sunset Rock Quarry, Inc., obtained quarrying permits at two locations along La Barge Creek and planned to produce "Teton Moss Back" rock, used for building surfaces.

Sweetwater.—The value of mineral production, fourth highest in the State, increased 3 percent. Of the total value, petroleum contributed 45 percent. Crude-oil output came from 18 fields; the largest producing field was Lost Soldier with 3.2 million barrels, followed by Patrick Draw with 2.3 million, and Arch Unit with 2.3 million. Natural gas production increased 6 percent; one new field was discovered in 1963. Natural gas processing plants were operated by Union Pacific Railroad Co. at the Patrick Draw field, Sinclair Oil & Gas Co. at the Lost Soldier field, and Gas Processors, Inc., at the Patrick Draw field. The plants recovered 1.4 million gallons of natural gasoline and 15.2 million gallons of LP gases.

Coal output, substantially below that of 1962, came from two underground operations: Gunn-Quealy Coal Co. and Edwin L. Swanson Brothers. Gunn-Quealy Coal Co., an affiliate of Kemmerer Coal Co., began constructing a plant near Rock Springs to produce rotary-kiln coke suitable for use in the electric-furnace method of processing elemental phosphorus; plant completion was scheduled for about August 1964.

Soda ash (sodium carbonate) production processed from trona increased in 1963. FMC Corp. increased output at the Westvaco plant,[13] and Stauffer Chemical Co. of Wyoming completed its first full year of operation. Stauffer Chemical Co. began constructing facilities, to

[13] Hartman, Henry G. Preventive Maintenance in Trona Mining. Min. Cong. J., v. 49, No. 6, June 1963, pp. 48–50.

be completed in the fourth quarter of 1964, for expanding the yearly processing capacity of the plant from 200,000 to 400,000 tons. At the Westvaco site, FMC Corp. planned to construct a multimillion dollar plant to produce sodium tripolyphosphate for the detergent industry. At its Westvaco facilities the company also announced production of a new product—sodium sesquicarbonate—a high-purity, white product made by crystallizing, centrifuging, and drying a specially prepared trona solution. The new product was to be used in hard household cleansers, as a filler in industrial and dairy cleansers, and in water-softening products. Texas Gulf Sulphur Co. was a high bidder to lease trona-bearing land in three areas, four sections per area, in the Green River basin of Wyoming. Gem stone collections of agate, fossil fish, jade (nephrite), mineral specimens, petrified wood, and turritella were valued at $22,000. Sand and gravel production more than doubled in 1963; the county was ranked second in the State in total output.

Teton.—Sand and gravel accounted for the bulk of the value of mineral output. Crushed limestone for Utah-Idaho Sugar Co. beet-sugar refining plants in Idaho was mined at the Fox Creek Canyon quarry east of Victor, Idaho. Gem stones collected were valued at $250.

Mountain States Mining & Milling Co. of Denver, Colo., began constructing a plant at the Bailey Bar in Snake River Canyon to recover gold from placer deposits. The plant was scheduled for operation in 1964.

Uinta.—The value of mineral production decreased 32 percent, mostly because of a decline in natural gas output from 9.2 to 6.2 billion cubic feet. Mountain Fuel Supply Co. processed natural gas from the Church Buttes field, producing 719,000 gallons of gasoline.

At quarries about 18 miles north of Evanston, International Pipe and Ceramics Corp. mined fire clay, and Interstate Brick Co. mined miscellaneous clay for building brick. The clay was transported to company plants in the Salt Lake City, Utah, area for use in manufacturing products. Sand and gravel production from three operations, 127,000 tons, was fivefold that of 1962.

Washakie.—Petroleum supplied 60 percent of the value of mineral production, followed by natural gas with 29, LP gases with 9, and lime and sand and gravel 2. Crude-oil output from 11 fields declined 167,000 barrels in 1963; Cottonwood Creek field had the largest production with 1.3 million barrels, followed by Worland with 198,000, Hidden Dome with 172,000, and Slick Creek with 168,000. One new oil discovery was reported. Natural gas output increased by 1.7 billion cubic feet. Pan American Petroleum Corp. at the Cottonwood Creek plant and Pure Oil Co. at the Worland plant produced 19.4 million gallons of LP gases. Texas Gulf Sulphur Co. processed an average daily throughput of 20 million cubic feet of natural gas from Pure Oil Co. and produced byproduct elemental sulfur at a plant near Worland. Pan American Petroleum Corp. also produced elemental sulfur at the Cottonwood Creek plant.

Holly Sugar Corp. processed lime from limestone for beet-sugar refining at Worland.

Weston.—The value of mineral output, decreasing by 5 percent below that of 1962, was distributed as follows: Petroleum 75 percent; bentonite 21 percent; and LP gases, natural gas, and sand and gravel 4. Petroleum production from 22 fields, 1 more than for 1962, declined 376,000 barrels; producing fields were Fiddler Creek with 1.5 million barrels, Clareton with 265,000 barrels and Osage with 244,000. Three oil discoveries were made. Natural-gas output decreased by 186 million cubic feet. Natural gas, processed by N. C. Ginther at the Lone Tree field and by Hy-Gas Products Co. at the Clareton field, yielded 4.5 million gallons of LP gases—1.1 million gallons less than in 1962.

Bentonite output advanced from 155,000 to 191,000 tons, an increase of 23 percent. Three companies produced and processed bentonite: American Colloid Co. and Archer-Daniels-Midland Co. with plants at Upton and Baroid Division of National Lead Co. with a plant at Osage. Production of sand and gravel from five operations was 80,000 tons, about the same quantity as in 1962.

Yellowstone National Park.—Sand and gravel production increased substantially over that of 1962. The Federal Bureau of Public Roads produced 1,700 tons of crushed stone for road construction.

U.S. GOVERNMENT PRINTING OFFICE:1964